

A Plant Experiment

A plant experiment is to be conducted to investigate five varieties and two spray regimes. Twelve pots containing a single seedling of each variety will be used and these are to be randomly assigned to six benches on each of which there are 10 positions so that there are two seedlings of each variety on each bench. The two spray regimes are to be randomly assigned to the benches so that each is applied to the pots on three benches. The height gain after six months is measured for each seedling in a pot.

The sets for this experiment are positions, seedlings and regimes and the tiers are $\mathcal{F}_{\text{positions}} = \{\text{Benches}, \text{Positions}\}$, $\mathcal{F}_{\text{seedlings}} = \{\text{Varieties}, \text{Seedlings}\}$ and $\mathcal{F}_{\text{regimes}} = \{\text{Regimes}\}$. This single-stage experiment involves two randomizations: the randomization of seedlings to positions and the randomization of regimes to positions. The randomizations are coincident as the different seedlings and the different spray regimes are both randomized to the benches.

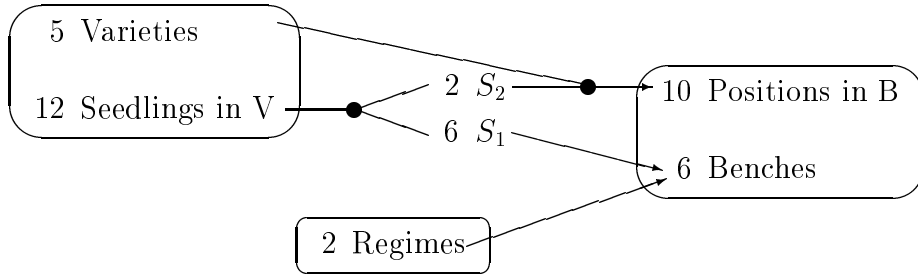


Figure 1: Coincident randomizations in for the plant experiment

This randomization is summarized in Figure 1, which introduces three new features. The first is that we have a factor from one tier, Seedlings (in Varieties), randomized two factors from the second tier, Benches and Positions (in Benches). To achieve this the seedlings within a variety are split into 6 sets of two and the sets are randomized to benches while the seedlings within a set (within a variety) are randomized to positions within benches. It is convenient to represent the formation of sets of seedlings by using pseudofactors (Monod and Bailey, 1992) S_1 and S_2 for Seedlings, with 6 and 2 levels respectively, so that $\text{Seedlings} = S_1 \wedge S_2$. We use the convention that pseudofactors have the same letter as the (real) factor and are distinguished by subscripts. The lines and black circle between Seedlings and the pseudofactors in the diagram portray this splitting of Seedlings into

the two pseudofactors. Now Varieties \wedge S_2 is randomized to Positions in Benches while S_1 is randomized to Benches. Note that the twelve levels of Seedlings, and therefore the levels of both S_1 and S_2 , must be randomly allocated within each level of Varieties. If, for example, the levels of S_1 correspond to different heights of seedling then S_1 is crossed with Varieties rather than nested in Varieties.

Another way of viewing the randomization of Seedlings (in Varieties) is that all 60 levels of the generalized factor Varieties \wedge Seedlings is randomized to the generalized factor Benches \wedge Positions subject to the constraint that Varieties are randomized to Positions within Benches.

The second new feature is that there are two arrows coming from the seedlings tier to the positions tier. All arrows from one tier to another represent a single randomization.

Finally, coincident randomizations are indicated by two arrowheads at the same factor. Not every combination of Seedlings and Regimes can occur: the confounding between Regimes and part of S_1 is indicated by the fact that both are randomized to Benches.

The structure formulae for this experiment are

$$\begin{aligned} & 6 \text{ Benches} / 10 \text{ Positions} \\ & (5 \text{ Varieties} / 12 \text{ Seedlings}) // (6 S_1) \\ & 2 \text{ Regimes} * \text{Varieties.} \end{aligned}$$

In this case Varieties has been included in both the second and third structure formulae. It is included in the second because Varieties and Seedlings form a tier as they were randomized together. It is included in the third because the experimenter would be interested in the interaction of Regimes with Varieties.

The Hasse diagrams displaying the structures for this experiment are given in Figure 2. As far as the conditions required for coincident randomizations are concerned, this experiment clearly meets the first condition, after the addition of a pseudofactor for Seedlings. Indeed, all terms in the structures corresponding to both seedlings and regimes are orthogonal to those for positions and the elements of the corresponding matrices of efficiencies are either zero or one. The second condition is also met with the subspaces corresponding to Regimes, Varieties and Regimes $\#$ Varieties each being a subspace of one of those corresponding to Varieties, S_1 and Seedlings [Varieties]. The analysis of variance table, that summarizes the relationships between subspaces for terms from different structure formulae, is given in Table 1.

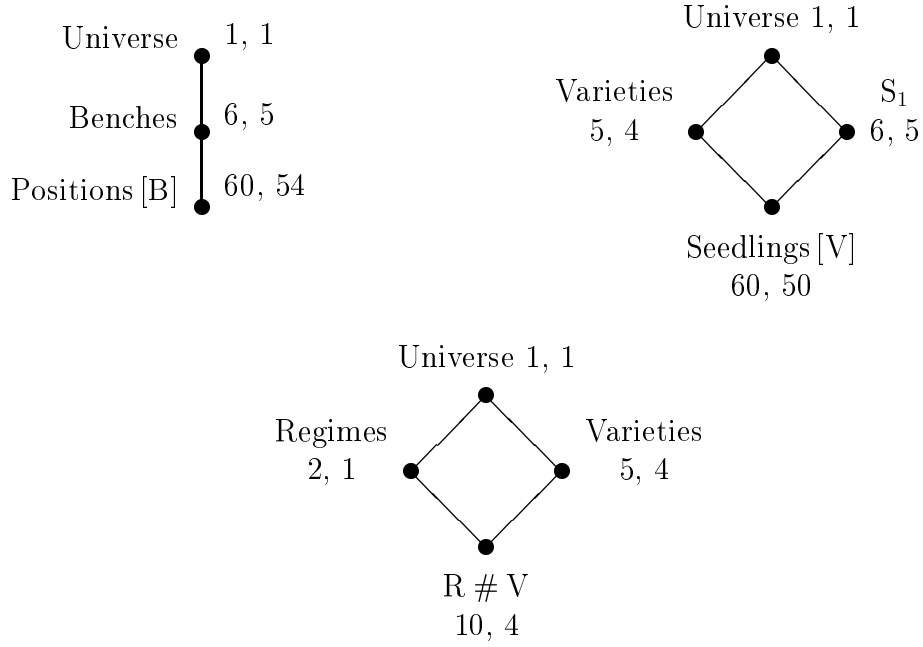


Figure 2: Hasse diagrams for the plant experiment

Source	DF	
Benches	5	
Seedlings [Varieties]	5	
Regimes		1
Residual		4
Positions [Benches]	54	
Varieties	4	
Seedlings [Varieties]	50	
Regimes # Varieties		4
Residual		46
Total	59	

Table 1: Analysis variance table for the plant experiment