BIOMETRICS INFORMATION

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SUBJECT: ANOVA: Factorial designs with a separate control

Experiments designed with a factorial arrangement of treatments often include a separate control (i.e. separate from the factorial but combined in the plot layout). An example would be a herbicide trial using three different herbicides, each at low and high application rates. The inclusion of a control treatment means that the experiment has a total of seven treatments with six of them arranged in a 3x2 factorial.

If analysis of variance is the appropriate statistical method, then the summary ANOVA Table should look like:

Source of Variation	Degrees of Freedom	Sums of Squares
Model:	6	SSM
Control	1	SSC = SSM-SSA-SSB-SSAB
Herbicide (A)	2	SSA
Rate (B)	1	SSB
AxB	2	SSAB
Error	7(n-1)	SSE
Total	7n-1	

where n is the number of experimental units randomly assigned to each of the seven treatments.

The sums of squares in the above Table can be obtained from two ANOVA Tables easily run on most computer packages. A new variable (TREAT) must be created to have 7 levels, one for each treatment combination in the experiment. The ANOVA Tables are listed below:

Table 1

Source of Variation	df	Sums of Squares
Herbicide (A)	2	SSA
Rate (B)	1	SSB
AxB	2	SSAB
Error	6(n-1)	not used

Table 2

Source of Variation	df	Sums of Squares
TREAT	6	SSM
Error	7(n-1)	SSE

NOTE 1: The ANOVA in Table 1 is run on a subset of the data (the control has been excluded), while Table 2 is run on all the data.

NOTE 2: It has been assumed that each treatment combination has data from an equal number (n) of experimental units.

NOTE 3: Subtraction of sums of squares from different ANOVA Tables requires that calculations be based on the same level of sampling. This means that if there is subsampling within experimental units (e.u.), then the ANOVA's must all be run either on the e.u. means or on the sampling values within the e.u.'s.

NOTE 4: If the number of sampling units is unequal for different e.u.'s, then using e.u. means is preferable.

NOTE 5: The test for CONTROL compares the control mean with the AVERAGE of all the other treatment means (this is clear from the contrast coefficients below). Other treatment comparisons are possible by using contrasts and multiple range tests.

An alternative method is to use contrasts in the one-way ANOVA on TREAT to obtain the sums of squares in the Summary Table. The sums of squares of the two contrasts for herbicide (and similarly for the interaction) must be added to obtain the appropriate sums of squares in the Summary Table. The following contrast coefficients would work:

Herbicide:		1	1	2	2	3	3	
Rate:		1	2	1	2	1	2	Control
TREAT:		1	2	3	4	5	6	7
Contrast Titles								
Control:		1	1	1	1	1	1	-6
Rate:		1	-1	1	-1	1	-1	0
Herbicide:	first:	1	1	0	0	-1	-1	0
	second:	1	1	-2	-2	1	1	0
Interactions:	first:	1	-1	0	0	-1	1	0
	second:	1	-1	-2	2	1	-1	0

These general methods, of using subset analysis and contrasts to obtain the required sums of squares, can be used for other types of incomplete factorial designs. For instance, the design described above could easily be extended to also include a manual cutting treatment. Assistance from a statistician is advised, as the details will vary with each situation.

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