Figure 1.24a

```
RUN NAME        4*4*3 FACTORIAL IN RANDOMIZED BLOCKS.
COMMENT         4*4*3 FACTORIAL IN RANDOMIZED BLOCKS WITH
                COVARIATE. FROM COCHRAN AND COX(1957)  PAGE 176.
VARIABLE LIST   REPLIC,LENPER,CURRENT,NTREAT,Y,X
INPUT MEDIUM    CARD
INPUT FORMAT    FIXED(4F1.0,F2.0,F3.0)
N OF CASES      96
IF              (LENPER EQ 5) LENPER = 4
IF              (NTREAT EQ 3) NTREAT = 2
IF              (NTREAT EQ 6) NTREAT = 3
MANOVA          Y BY REPLIC(1,2), LENPER(1,4), CURRENT(1,4),
                     NTREAT(1,3) WITH X/
                DESIGN = REPLIC,NTREAT,LENPER,CURRENT,NTREAT BY LENPER,
                         NTREAT BY CURRENT, LENPER BY CURRENT,
                         NTREAT BY LENPER BY CURRENT/

READ INPUT DATA
111172152
111374131
111669131
112161130
112361129
112665126
113162141
113365112
113670111
114185147
114376125
114661130
121167136
121352110
121662122
122160111
 . . . .
 . . . .
 . . . .
254159102
254358 98
254688135
FINISH
```

Figure 1.24b

TESTS OF SIGNIFICANCE FOR Y USING SEQUENTIAL SUMS OF SQUARES

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIG. OF F
RESIDUAL	2211.96526	46	48.08620		
REGRESSION	987.52432	1	987.52432	20.53654	.000
CONSTANT	1316.19933	1	1316.19933	27.37166	0.0
REPLIC	.27456	1	.27456	.00571	.940
NTREAT	441.20522	2	220.60261	4.58765	.015
LENPER	180.52285	3	60.17428	1.25138	.302
CURRENT	2111.03300	3	703.67767	14.63367	0.0
NTREAT BY LENPER	211.79056	6	35.29843	.73407	.625
NTREAT BY CURRENT	467.84848	6	77.97475	1.62156	.163
LENPER BY CURRENT	404.37365	9	44.93041	.93437	.505
NTREAT BY LENPER BY CURRENT	1021.61800	18	56.75656	1.18031	.315

1.25 Nested Designs

A nested design arranges the experimental units hierarchically. For example, consider an experiment to compare the yield of wheat per acre for different areas in a given state. Five counties are selected at random, then three townships are randomly selected from each county. From each township two farms are selected and the yield of wheat per acre is obtained. The resulting experiment produces $5 \times 3 \times 2 = 30$ experimental units. The factors of this experiment are county and township, and the township effects are *nested* under the county factor, since a given township appears only under one of the five counties. In other words, the county factor is not *crossed* with township factor and so the interaction between county and township is not estimable.

The model for this two-factor nested design is

$$Y_{ijk} = \mu + \alpha_i + \beta_{j(i)} + \epsilon_{ijk}$$

where α_i is the county effect and $\beta_{j(i)}$ is the township effect nested under the county effect.