Latin Square Example

This example is taken from Steel and Torrie. Four varieties (A, B, C, D) of wheat are compared in a Latin square design. Response is yield.

Notes:

1. The primary research questions are focused on comparing means for the 4 varieties. This can be done using the ANOVA table (using Anova) and pairwise comparisons (using emmeans).
2. Row and Col are included in the model to account for the experimental design.

```
library(car)
library(emmeans)
LSData <- read.csv("C:/hess/STAT512/RNotes/ExpDesign1/ED1_LatinSquare.csv")
str(LSData)
```

```
## 'data.frame':    16 obs. of  4 variables:
##  $ row  : int  1 1 1 1 2 2 2 2 3 3 ...
##  $ col  : int  1 2 3 4 1 2 3 4 1 2 ...
##  $ trt  : Factor w/ 4 levels "A","B","C","D": 3 4 2 1 2 1 3 4 4 3 ...
##  $ yield: num  10.5 7.7 12 13.2 11.1 12 10.3 7.5 5.8 12.2 ...
```

```
#Important: Need to define row and col as.factor!
LSData$row <- as.factor(LSData$row)
LSData$col <- as.factor(LSData$col)
Model <- lm(yield ~ row + col + trt, data = LSData)
Anova(Model, type = 3)
```

```
## Anova Table (Type III tests)
##
## Response: yield
##              Sum Sq Df  F value    Pr(>F)
## (Intercept) 219.024  1 483.1412 5.794e-07 ***
## row           1.955  3   1.4375    0.3219
## col           6.800  3   5.0000    0.0452 *
## trt          78.925  3  58.0331 7.987e-05 ***
## Residuals     2.720  6
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
emmeans(Model, pairwise ~ trt)
```

```
## $emmeans
##  trt emmean        SE df  lower.CL  upper.CL
##  A   12.000 0.3366502  6 11.176247 12.823753
##  B   12.275 0.3366502  6 11.451247 13.098753
##  C   10.800 0.3366502  6  9.976247 11.623753
##  D    6.725 0.3366502  6  5.901247  7.548753
##
## Results are averaged over the levels of: row, col
## Confidence level used: 0.95
##
## $contrasts
##  contrast estimate        SE df t.ratio p.value
##  A - B      -0.275 0.4760952  6  -0.578  0.9353
```

```
##  A - C       1.200 0.4760952  6   2.521  0.1533
##  A - D       5.275 0.4760952  6  11.080  0.0001
##  B - C       1.475 0.4760952  6   3.098  0.0765
##  B - D       5.550 0.4760952  6  11.657  0.0001
##  C - D       4.075 0.4760952  6   8.559  0.0006
##
## Results are averaged over the levels of: row, col
## P value adjustment: tukey method for comparing a family of 4 estimates
```