

| Source      | DF | SS       | MS       | F       | P     |
|-------------|----|----------|----------|---------|-------|
| A           | 2  | 220.0200 | 110.0100 | 1827.86 | 0.000 |
| B           | 2  | 123.6600 | 61.8300  | 1027.33 | 0.000 |
| Interaction | 4  | 29.4250  | 7.3562   | 122.23  | 0.000 |
| Error       | 27 | 1.6250   | 0.0602   |         |       |

1) The output above is from an experiment on hay fever. 36 volunteers were given medicine. The two active ingredients (factors A and B) in the medicine were varied at three levels each (low, medium, and high). The response is the number of hours of relief. (The factor names for this problem are "A" and "B.")

a) Give a four step test for the "A\*B" interaction.

$H_0$  no interaction       $H_A$  there is an interaction

$$F_{AB} = 122.23$$

$$pval = 0$$

reject  $H_0$ , there is an interaction between A and B, the two active ingredients.

b) Give a four step test for the A main effects.

$H_0 \mu_1 = \mu_2 = \mu_3$        $H_A$  not  $H_0$

(3 A levels)

$$F_A = 1827.86$$

$$pval = 0$$

reject  $H_0$  the mean hours of relief depend on A.

c) Give a four step test for the B main effects.

$H_0 \mu_1 = \mu_2 = \mu_3$        $H_A$  not  $H_0$

(3 B levels)

$$F_B = 1027.33$$

$$pval = 0$$

reject  $H_0$ , the mean hours of relief depends on B.

| Source    | df | SS      | MS     | F    | P     |
|-----------|----|---------|--------|------|-------|
| blocks    | 3  | 197.004 | 65.668 | 9.12 | 0.001 |
| treatment | 5  | 201.316 | 40.263 | 5.59 | 0.004 |
| error     | 15 | 108.008 | 7.201  |      |       |

2) Current nitrogen fertilization recommendations for wheat include applications of specified amounts at specified stages of plant growth. The treatment consisted of six different nitrogen application and rate schedules. The wheat was planted in an irrigated field that had a water gradient in one direction as a result of the irrigation. The field plots were grouped into four blocks, each consisting of six plots, such that each block occurred in the same part of the water gradient. The response was the observed nitrogen content from a sample of wheat stems from each plot. The experimental units were the 24 plots.

a) Did blocking help? Explain briefly.

Yes  $P_b = 0.001 < 0.05$

b) Perform the appropriate 4 step test using the output above.

(6 levels)

$H_0: \mu_1 = \mu_2 = \dots = \mu_6$      $H_A: \text{not } H_0$

$F_0 = 5.59$

$p_{val} = 0.004$

reject  $H_0$  the mean nitrogen content

depends on the treatment

(nitrogen application and rate schedule).