Field Trials Seminar Part 2: Statistics
Dr. Nicole Fiorellino
Assistant Professor & Extension Agronomist

Understanding Scientific Literature
Why read scientific literature?

- Investigate what has already been done
- Evaluate data collected and conclusions drawn by authors
  - May not always parallel
  - Scope of inference

Tricks for interpreting data

- Regression: What is the slope of the line?
  - Determines the relationship between the variables
Tricks for interpreting data

- Regression: What is the slope of the line?
  - Determines the relationship between the variables

- What is the $R^2$?
  - Describes how well the regression line fits the data – is this a good predictive relationship
Tricks for interpreting data

• What is the slope of the line?
  • Determines the relationship between the variables

• What is the $R^2$?
  • Describes how well the regression line fits the data – is this a good predictive relationship

• How large are the error bars on a bar plot?
  • Determines the variability of data in each treatment
  • If the bars overlap, too much variability to determine a treatment effect

Fig. 2. Retained protein in response to lysine intake at different weight classes of Nile tilapia (S, M and L) after 12 weeks. The equations that best describe the response at each weight class are as follows: Y = 9.69 ($\pm$ 0.48)X + 0.02 ($\pm$ 0.21) (n = 5), $r^2$ = 0.98, $P < .0001$ for S; Y = 8.97 ($\pm$ 0.65)X - 0.77 ($\pm$ 0.49) (n = 5), $r^2$ = 0.97, $P < .0001$ for M; Y = 7.05 ($\pm$ 0.47)X - 7.06 ($\pm$ 0.96) (n = 5), $r^2$ = 0.97, $P < .0001$ for L; where Y = retained protein (g/fish), X = lysine intake (g/fish).
**Corn Yield (bu/ac)**

- **TRT A**: 180
- **TRT B**: 176
- **TRT C**: 170

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**Cumulative P removal, kg ha⁻¹**

- **CMREC**
  - **Forage**
  - **Grain**

- **0**: c
- **400**: a, c
- **800**: ab, bc
- **1200**: d, de
- **1600**: e, bc
Exercise – Mock Journal Club

• Everyone should have read the paper “Phosphite alters the behavioral response of potato tuber moth (*Phthorimaea operculella*) to field-grown potato”

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Trt 1</th>
<th>Trt 2</th>
<th>Trt 3</th>
</tr>
</thead>
<tbody>
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<td>Block 3</td>
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<tr>
<td>Block 4</td>
<td>152</td>
<td>160</td>
<td>169</td>
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</tbody>
</table>
Trish Example Data

Proc Mixed Output
Mixed Model ANOVA

Perform an overall F test:
Are means of the treatments the same?

If F test is significant, means are different, we determine which means are different
Perform an overall F test: Are means of the treatments the same?

If F test is significant, means are different, we determine which means are different.
Trish Example Data

Proc ANOVA Output

The ANOVA Procedure

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>5</td>
<td>2583.333333</td>
<td>516.666667</td>
<td>14.18</td>
<td>0.0028</td>
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<tr>
<td>Error</td>
<td>6</td>
<td>218.666667</td>
<td>36.444444</td>
<td></td>
<td></td>
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<tr>
<td>Corrected Total</td>
<td>11</td>
<td>2802.000000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R-Square: 0.21967
Coeff Var: 4.35208
Root MSE: 6.02383

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<tbody>
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<td>int</td>
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<td>290.000000</td>
<td>145.000000</td>
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<td>0.1425</td>
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<tr>
<td>rep</td>
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<td>2383.333333</td>
<td>794.444444</td>
<td>21.04</td>
<td>0.0001</td>
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</tbody>
</table>

FEARLESS IDEAS

Trish Example Data

- \( P > F = 0.1425 \)
- Not significant!
- Don’t even bother with the mean comparisons – they are not different from each other
Trish Example Data

- 4 treatments, 3 reps

<table>
<thead>
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<th>Trt 3</th>
<th>Trt 4</th>
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</thead>
<tbody>
<tr>
<td>Rep 1</td>
<td>156</td>
<td>178</td>
<td>200</td>
<td>169</td>
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<tr>
<td>Rep 2</td>
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<td>Rep 3</td>
<td>158</td>
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<tr>
<td>Rep 4</td>
<td>150</td>
<td>174</td>
<td>202</td>
<td>164</td>
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</table>

Nicole Example Data
Nicole Example Data

Proc Mixed Output
Mixed Model ANOVA
Tukey's post-hoc test
\( \alpha = 0.1 \)

Check if the overall F test is significant…
are means different?
Nicole Example Data

Proc Mixed Output
Mixed Model ANOVA
Tukey's post-hoc test
α = 0.1

Significant...yay!
Now we can look below at the mean comparisons

Nicole Example Data

• Proc ANOVA output, α = 0.1
Nicole Example Data

Proc Mixed Output
Mixed Model ANOVA
Tukey’s post-hoc test
\( \alpha = 0.1 \)

Treatment pairwise comparisons
Nicole Example Data

Proc Mixed Output
Mixed Model ANOVA
Tukey's post-hoc test
\( \alpha = 0.1 \)

**Significant difference between all treatments except two**

All treatments differ except Trt 2 and Trt 4
Nicole Example Data

Tukey's post-hoc test
\( \alpha = 0.1 \)

Mean Corn Yield

- Trt 1
- Trt 2
- Trt 3
- Trt 4

Proc ANOVA, \( \alpha = 0.1 \)

\* Tests (LSED) for yield

Note: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

<table>
<thead>
<tr>
<th>Alpha</th>
<th>Error Degrees of Freedom</th>
<th>Error Mean Square</th>
<th>Critical Value of t</th>
<th>Least Significant Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>9</td>
<td>12.72917</td>
<td>1.83311</td>
<td>4.0249</td>
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</table>

Means with the same letter are not significantly different.

<table>
<thead>
<tr>
<th>t Grouping</th>
<th>Mean</th>
<th>N Trt</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>198.500</td>
<td>4.3</td>
</tr>
<tr>
<td>B</td>
<td>174.000</td>
<td>4.2</td>
</tr>
<tr>
<td>C</td>
<td>167.750</td>
<td>4.4</td>
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<tr>
<td>D</td>
<td>154.300</td>
<td>4.1</td>
</tr>
</tbody>
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Nicole Example Data

- Proc ANOVA, $\alpha = 0.1$

$t$ Tests (LSD) for yield

Note: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

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<td>4.6246</td>
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