

1. A experiment was conducted to compare the effectiveness of three fungicides (A, B, and C) at protecting corn seed from fungus damage. The three fungicides and a control treatment (D) were randomly assigned to 20 batches of corn seed so that there are 5 batches for each of the four treatments (A, B, C, and D). Each batch of treated seeds was planted in 6 plots. The number of plants reaching maturity was recorded for each plot. Some SAS code and output are provided below.

```
proc glm;
  class trt batch;
  model count=trt batch(trt) / E1;
  random batch(trt);
  means trt;
run;
```

The GLM Procedure
 Dependent Variable: count

Source	DF	Mean Square	F Value	Pr > F
Model	?	38.636404	1.75	0.0400
Error	?	22.088333		
Corrected Total	?			

Source	DF	Mean Square	F Value	Pr > F
trt	?	107.0083333	4.84	0.0034
batch(trt)	?	25.8166667	1.17	0.3061

Source	Type I Expected Mean Square
trt	Var(Error) + 6 Var(batch(trt)) + Q(trt)
batch(trt)	Var(Error) + 6 Var(batch(trt))

Level of trt	N	Mean	Std Dev
A	30	25.7666667	4.07416870
B	30	24.4666667	4.63668530
C	30	26.6000000	4.22308924
D	30	22.2666667	5.87181070

- What are the experimental units?
- What are the observational units?
- How many replications are there for each treatment?
- Give the degrees of freedom for MODEL, ERROR, C. TOTAL, TRT, and BATCH(TRT) missing from the output above.
- Are there any significant differences among the treatment means? Conduct an appropriate test to answer this question. Compute a test statistic, determine its degrees of freedom, provide an appropriate table value, and state a conclusion at the 0.05 significance level.

- (f) Compute a 95% confidence interval for the difference between the treatment A mean and the mean for the control treatment D.
- (g) Based on your 95% confidence interval, does it appear that treatment A is significantly better than the control at preventing fungus damage? Explain briefly.
- (h) Give a point estimate of the variance of batches within treatments.
2. An experiment was conducted to determine the effects of four different pesticides on the yield of fruit from three different varieties of a citrus tree. Eight trees from each variety were randomly selected from an orchard. The four pesticides were then randomly assigned to two trees of each variety. Yields of fruit (in bushels per tree) were obtained after the test period. Some SAS output and the mean yields for each combination of pesticide and variety appear below.

The GLM Procedure

Dependent Variable: yield

Source	Sum of Squares
Model	6680.458333
Error	507.500000
Corrected Total	7187.958333

Source	Type I SS
pesticide	2227.458333
variety	3996.083333
pesticide*variety	456.916667

Pesticide	Variety			Pesticide Means
	1	2	3	
1	44	48	67	53.00
2	52.5	62.5	88.5	67.83
3	40.5	47.5	65.5	51.17
4	50.5	79	92	73.83
Variety Means	46.875	59.25	78.25	

- (a) Provide the degrees of freedom corresponding to each of the sums of squares in the output above.
- (b) Do the effects of the pesticides on yield depend on the variety of citrus tree? Conduct an appropriate test to answer this question. Compute a test statistic, determine its degrees of freedom, provide an appropriate table value, and state a conclusion at the 0.05 significance level.
- (c) Suppose Pesticides 1 and 2 are sold by company A and pesticides 3 and 4 are sold by company B. Conduct a test or construct a confidence interval that can be used to compare the effectiveness of company A's insecticides to the effectiveness of company B's insecticides. Show your work and provide a conclusion that someone with no statistical training should be able to understand.