MULTI-YEAR ANALYSIS OF SPRING FERTILIZER RATES IN THE NORTHERN TEXAS BLACKLANDS

Samuel Uche, Curtis Jones, David Drake and Jose Lopez
College of Agriculture and Natural Sciences, Texas A&M University- Commerce

INTRODUCTION

Multiple regression analysis is a common procedure for analyzing experiments that are time series and cross sectional. For example, Leilah et al (2005), Anderson et al (1993), and Lobell et al (2005) have all used a regression approach in the analysis of wheat.

Analysis of variance (ANOVA) is also common in field trial experiments that involve two or three years. For example, Baril (1992), Korzun et al (1998), and Mohapatra et al (2005) have all used an ANOVA approach in the analysis of wheat.

ANOVA is a method for comparing the fit of two models: a single mean model (which is a reduced or restricted model) versus the group means model (which is the full or unrestricted model).

It is usually expected that either a regression design or a ANOVA design will result in consistent results.

To illustrate the applications of models that can be used to conduct multi-year analysis this study chose a field trial experiment of spring fertilizer rates on winter wheat in the Northern Texas Blacklands.

According to USDA, wheat ranks third among U.S. field crops in planted acreage, production, and gross farm receipts, behind corn and soybeans (USDA, 2016). In Texas, wheat for grain is one of the most valuable cash crops, usually exceeded in value only by cotton lint, sorghum, and rice.

Planting, cultivation and harvesting of wheat is done mechanically. High quality hard red winter wheat is used in the production of commercial bakery flour. Lower grades and varieties of soft red winter wheat are used in family flours.

RESEARCH OBJECTIVES

The main objective of this study is to present statistical models that can be used to conduct a multi-year and location analysis of spring fertilizer rates in the northern Texas Blacklands.

The specific objectives are:

1. To discuss multiple regression and ANOVA models,
2. To estimate and interpret the findings from the regression analysis,
3. To estimate and interpret findings using ANOVA.

METHODOLOGY

The data for this study was gathered from three locations Royse City, Leonard and Howe over three years (2010, 2011, and 2012) and comprised of three wheat varieties Syngenta Magnolia, Syngenta Jackpot, and Fannin. The data evaluated the effect of spring fertilizer rates on winter wheat in the northern Texas Blacklands.

Multiple linear regression was carried out to ascertain if there is a statistical difference in the yield between the three locations and across the three years with respect to spring fertilizer rates. SAS version 9.4 was used to conduct the regression analysis.

Empirical Models

- A multiple linear regression model was estimated:

  $$Y_{yield} = \beta_0 + \beta_1 Trt_2 + \beta_2 Trt_3 + \beta_3 Trt_4 + \beta_4 Trt_5 + \beta_5 Trt_6 + e$$

  where Y_{yield} is the yield of wheat in kg/ha, Trt_2 to Trt_6 are dummy variables for treatment. Ttr_1 (or control) was excluded from the model to avoid the problem of perfect multicollinearity.
- An ANOVA model was also estimated for the variable yield by treatments regardless of the year and location. The following ANOVA model was analyzed.

  $$y_{ij} \sim \mu_i + \epsilon_{ij} \quad \text{or} \quad y_{ij} \sim \mu + \alpha_i + \epsilon_{ij}$$

  where y_{ij} = j^{th} response in the i^{th} treatment group, i = 1, 2, … 6; j = 1, 2, …, n_i in treatment group i; μ_i is the mean in the treatment group i; μ is the overall mean; α_i is the i^{th} treatment effect; and e_{ij} = independent, normally distributed errors with mean zero and variance σ^2.
- Both models were estimated using SAS version 9.4.

RESULTS

Multiple Regression

Table 1. Analysis of Variance

Parameter Estimates						
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	53.3188	3.3087	16.11	<.0001
Trt2		1	4.4250	4.6791	0.95	0.3468
Trt3		1	16.9125	4.6791	3.61	0.0005
Trt4		1	19.7250	4.6791	4.22	<.0001
Trt5		1	19.5313	4.6791	4.17	<.0001
Trt6		1	20.5500	4.6791	4.39	<.0001

Table 2. Parameter Estimates

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	6417.22	1283.44	7.33	<.0001
Error	90	15764	175.15		
Corrected Total	95	22181			

ANOVA

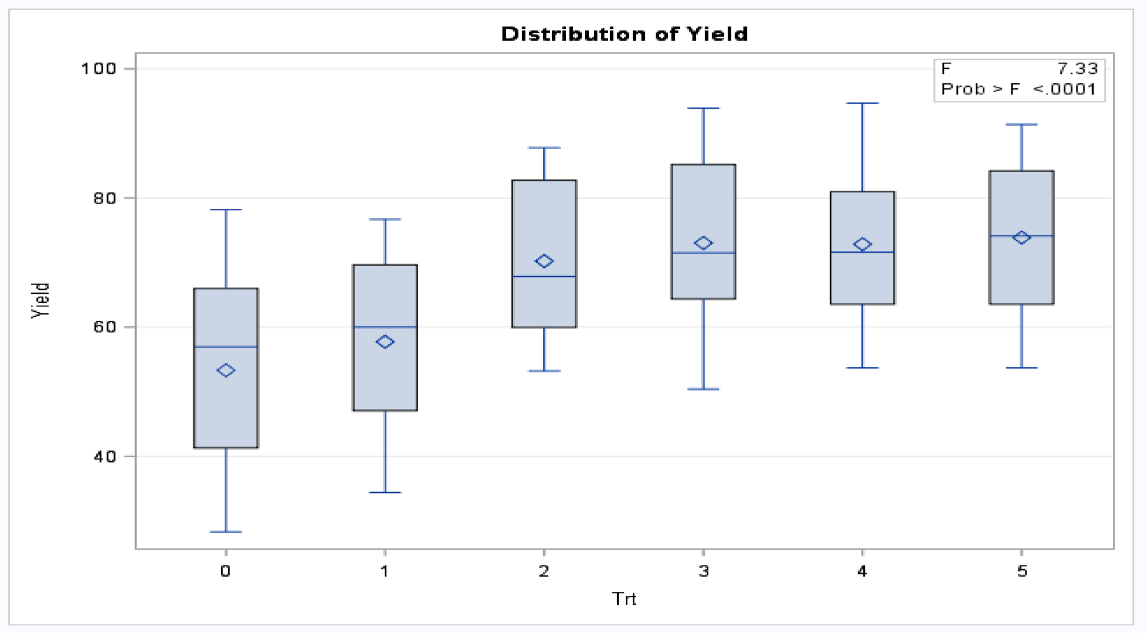
Table 3. Analysis of Variance

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	6417.22	1283.44	7.33	<.0001
Error	90	15764	175.15		
Corrected Total	95	22181			

Table 4. Tukey's Test

Means with the same letter are not significantly different.				
Tukey Grouping		Mean	N	Trt
	A	73.869	16	6
	A			
	A	73.044	16	4
	A			
	A	72.850	16	5
	A			
B	A	70.231	16	3
B				
B	C	57.744	16	2
	C			
	C	53.319	16	1

Figure 1. Distribution of yield by treatments, 2010-2012



Multiple Regression

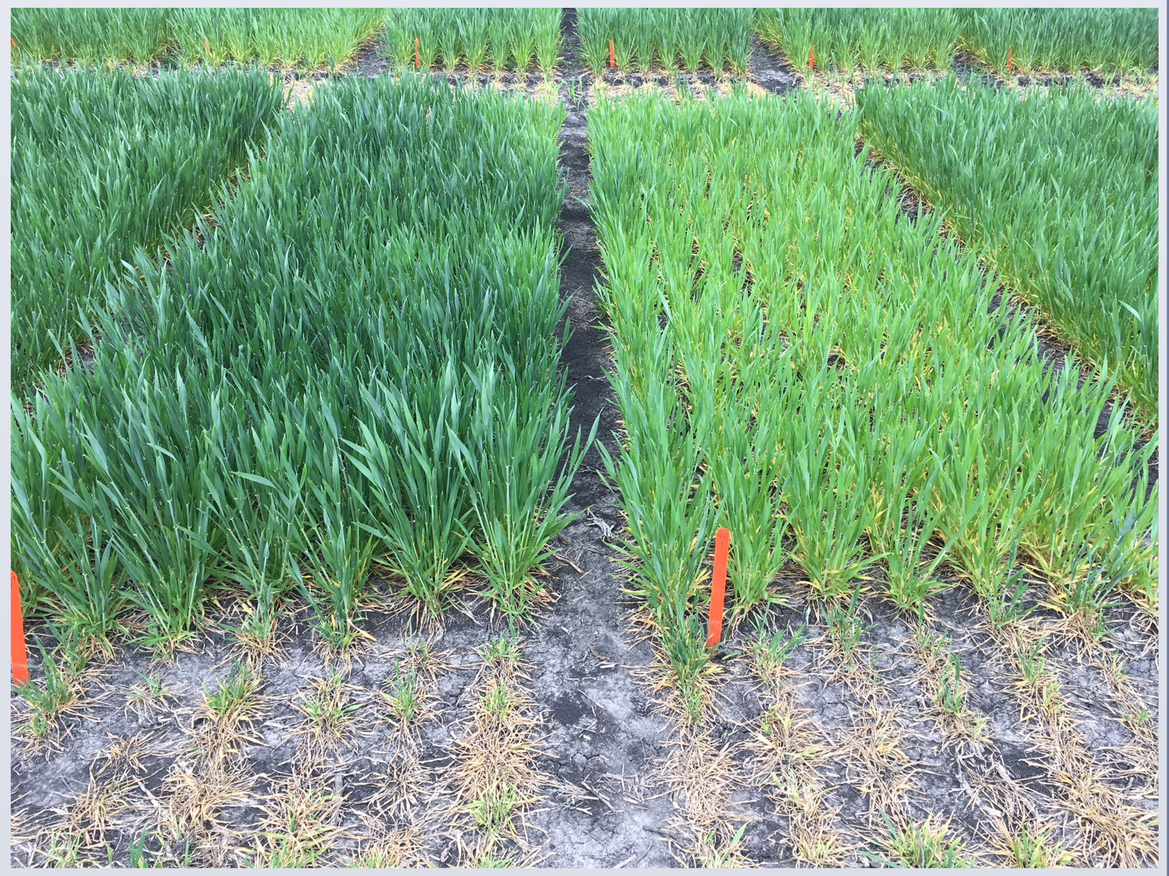
- The F test statistic was statistically significance at the 5% significance level. There is enough statistical evidence to conclude that at least one of the dummy variables affects the dependent variable (yield).
- The parameter estimates associated with dummy variables trt3, trt4, trt5 and trt6 were statistically significant at the 5% significance level indicating trt3 through trt6 were all higher that the control.

RESULTS

ANOVA

- F test statistic showed significance at the 5% significance level indicating that there is enough statistical evidence to conclude that at least one of the means is different from the others.
- Tukey's test results suggest that the population means from trt6, trt4, trt5, and trt3 are not statistically different from each other. It also shows that the population means from trt3 and trt2 and trt 2 and trt 1 are not statistically different from each other respectively.

Figure 2. Winter wheat fertility trial plots 100 pounds N per acre plot, on left, 0 N right; at Greenville, TX. March 2010.



CONCLUSION

The results from the regression analysis and the ANOVA showed that the two approaches are consistent. However, the ANOVA approach is more practical since it allows for multiple means comparisons without having to estimate the model multiple times as in multiple regression.

REFERENCES

1. United States Department of Agriculture, Economic Research Service, Online Database, (2016).