

```

1 *****;
2 *** Example of CRD with 2 levels of error ***;
3 *** From Snedecor & Cochran, 1980 (pg 248) ***;
4 *****;
5 OPTIONS PS=256 LS=111 NOCENTER NODATE NONUMBER;
6 DATA CALCIUM; INFILE CARDS MISSEVER;
7 INPUT PLANT LEAF SAMPLE CALCIUM;
8 TITLE1 'CALCIUM CONCENTRATION IN TURNIP LEAVES';
9 TITLE2 '4 PLANTS, 3 LEAVES AND 2 SAMPLES OF 100 MG PER LEAF';
10 CARDS;

```

NOTE: The data set WORK.CALCIUM has 24 observations and 4 variables.

NOTE: DATA statement used:

```

real time      0.06 seconds
cpu time       0.06 seconds

```

```
10 ! RUN;
```

```
35 ;
```

```
36 PROC PRINT; TITLE3 'RAW DATA LISTING'; RUN;
```

NOTE: There were 24 observations read from the data set WORK.CALCIUM.

NOTE: The PROCEDURE PRINT printed page 1.

NOTE: PROCEDURE PRINT used:

```

real time      0.03 seconds
cpu time       0.02 seconds

```

CALCIUM CONCENTRATION IN TURNIP LEAVES

4 PLANTS, 3 LEAVES AND 2 SAMPLES OF 100 MG PER LEAF

RAW DATA LISTING

Obs	PLANT	LEAF	SAMPLE	CALCIUM
1	1	1	1	3.28
2	1	1	2	3.09
3	1	2	1	3.52
4	1	2	2	3.48
5	1	3	1	2.88
6	1	3	2	2.80
7	2	1	1	2.46
8	2	1	2	2.44
9	2	2	1	1.87
10	2	2	2	1.92
11	2	3	1	2.19
12	2	3	2	2.19
13	3	1	1	2.77
14	3	1	2	2.66
15	3	2	1	3.74
16	3	2	2	3.44
17	3	3	1	2.55
18	3	3	2	2.55
19	4	1	1	3.78
20	4	1	2	3.87
21	4	2	1	4.07
22	4	2	2	4.12
23	4	3	1	3.31
24	4	3	2	3.31

```

37 PROC MIXED DATA=CALCIUM cl covtest; CLASSES PLANT LEAF SAMPLE;
38 TITLE3 'Analysis OF Variance with PROC MIXED - Nested Error';
39 MODEL CALCIUM = / htype=1 DDFM=Satterthwaite outp=ResidDataP;
40 RANDOM PLANT LEAF(PLANT);
41 RUN;

```

NOTE: Convergence criteria met.

NOTE: The data set WORK.RESIDDATA P has 24 observations and 11 variables.

NOTE: The PROCEDURE MIXED printed page 2.

NOTE: PROCEDURE MIXED used:

```

real time      0.16 seconds
cpu time       0.16 seconds

```

```
41 ! QUIT;
```

## CALCIUM CONCENTRATION IN TURNIP LEAVES

4 PLANTS, 3 LEAVES AND 2 SAMPLES OF 100 MG PER LEAF

Analysis OF Variance with PROC MIXED - Nested Error

## The Mixed Procedure

## Model Information

Data Set	WORK.CALCIUM
Dependent Variable	CALCIUM
Covariance Structure	Variance Components
Estimation Method	REML
Residual Variance Method	Profile
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Satterthwaite

## Class Level Information

Class	Levels	Values
PLANT	4	1 2 3 4
LEAF	3	1 2 3
SAMPLE	2	1 2

## Dimensions

Covariance Parameters	3
Columns in X	1
Columns in Z	16
Subjects	1
Max Obs Per Subject	24
Observations Used	24
Observations Not Used	0
Total Observations	24

## Iteration History

Iteration	Evaluations	-2 Res Log Like	Criterion
0	1	49.90596741	
1	1	2.17294242	0.00000000

Convergence criteria met.

## Covariance Parameter Estimates

Cov Parm	Estimate	Standard Error	Z		Alpha	Lower	Upper
			Value	Pr Z			
PLANT	0.3652	0.3440	1.06	0.1442	0.05	0.1042	10.1188
LEAF(PLANT)	0.1611	0.08220	1.96	0.0250	0.05	0.07253	0.6127
Residual	0.006654	0.002717	2.45	0.0072	0.05	0.003422	0.01813

## Fit Statistics

-2 Res Log Likelihood	2.2
AIC (smaller is better)	8.2
AICC (smaller is better)	9.4
BIC (smaller is better)	6.3

```

42     PROC MIXED DATA=CALCIUM cl covtest method=type1;
43     CLASSES PLANT LEAF SAMPLE;
44     TITLE3 'Analysis OF Variance with Type I SS - Nested Error';
45     MODEL CALCIUM = / htype=1 DDFM=Satterthwaite outp=ResidDataP;
46     RANDOM PLANT LEAF(PLANT);
47     RUN;

```

NOTE: The data set WORK.RESIDDATAP has 24 observations and 11 variables.

NOTE: The PROCEDURE MIXED printed page 3.

NOTE: PROCEDURE MIXED used:

real time	0.15 seconds
cpu time	0.15 seconds

```

47     !      QUIT;

```

**CALCIUM CONCENTRATION IN TURNIP LEAVES**

4 PLANTS, 3 LEAVES AND 2 SAMPLES OF 100 MG PER LEAF

Analysis OF Variance with Type I SS - Nested Error

The Mixed Procedure

## Model Information

Data Set WORK.CALCIUM  
 Dependent Variable CALCIUM  
 Covariance Structure Variance Components  
 Estimation Method Type 1  
 Residual Variance Method Factor  
 Fixed Effects SE Method Model-Based  
 Degrees of Freedom Method Satterthwaite

## Class Level Information

Class	Levels	Values
PLANT	4	1 2 3 4
LEAF	3	1 2 3
SAMPLE	2	1 2

## Dimensions

Covariance Parameters	3
Columns in X	1
Columns in Z	16
Subjects	1
Max Obs Per Subject	24
Observations Used	24
Observations Not Used	0
Total Observations	24

## Type 1 Analysis of Variance

Source	DF	Sum of Squares	Mean Square	Expected Mean Square	Error Term	Error DF
PLANT	3	7.560346	2.520115	Var(Residual) + 2 Var(LEAF(PLANT)) + 6 Var(PLANT)	MS(LEAF(PLANT))	8
LEAF(PLANT)	8	2.630200	0.328775	Var(Residual) + 2 Var(LEAF(PLANT))	MS(Residual)	12
Residual	12	0.079850	0.006654	Var(Residual)	.	.

## Type 1 Analysis of Variance

Source	F Value	Pr > F
PLANT	7.67	0.0097
LEAF(PLANT)	49.41	<.0001
Residual	.	.

## Covariance Parameter Estimates

Cov Parm	Estimate	Standard Error	Z Value	Pr Z	Alpha	Lower	Upper
PLANT	0.3652	0.3440	1.06	0.2884	0.05	-0.3091	1.0395
LEAF(PLANT)	0.1611	0.08220	1.96	0.0501	0.05	-0.00006	0.3222
Residual	0.006654	0.002717	2.45	0.0072	0.05	0.003422	0.01813

## Fit Statistics

-2 Res Log Likelihood	2.2
AIC (smaller is better)	8.2
AICC (smaller is better)	9.4
BIC (smaller is better)	6.3

```
48      proc univariate data=ResidDataP plot normal; var resid;
49          TITLE3 'Univariate analysis for PROC MIXED - Nested Error';
50      run;
```

NOTE: The PROCEDURE UNIVARIATE printed page 4.

NOTE: PROCEDURE UNIVARIATE used:

real time	0.03 seconds
cpu time	0.03 seconds

CALCIUM CONCENTRATION IN TURNIP LEAVES  
 4 PLANTS, 3 LEAVES AND 2 SAMPLES OF 100 MG PER LEAF  
 Univariate analysis for PROC MIXED - Nested Error

The UNIVARIATE Procedure

Variable: Resid

Moments			
N	24	Sum Weights	24
Mean	0	Sum Observations	0
Std Deviation	0.05933696	Variance	0.00352087
Skewness	0.380389	Kurtosis	2.28744979
Uncorrected SS	0.08098011	Corrected SS	0.08098011
Coeff Variation	.	Std Error Mean	0.01211211

Basic Statistical Measures			
Location		Variability	
Mean	0.00000	Std Deviation	0.05934
Median	-0.00677	Variance	0.00352
Mode	-0.00829	Range	0.30000
		Interquartile Range	0.05477

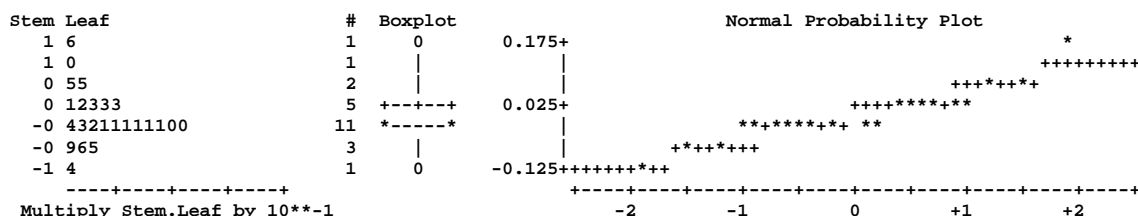
NOTE: The mode displayed is the smallest of 3 modes with a count of 2.

Tests for Location: Mu0=0				
Test	-Statistic-		-----p Value-----	
Student's t	t	0	Pr >  t	1.0000
Sign	M	-3	Pr >=  M	0.3075
Signed Rank	S	-6	Pr >=  S	0.8681

Tests for Normality				
Test	--Statistic--		-----p Value-----	
Shapiro-Wilk	W	0.942796	Pr < W	0.1882
Kolmogorov-Smirnov	D	0.144029	Pr > D	>0.1500
Cramer-von Mises	W-Sq	0.115831	Pr > W-Sq	0.0676
Anderson-Darling	A-Sq	0.644916	Pr > A-Sq	0.0849

Quantiles (Definition 5)	
Quantile	Estimate
100% Max	0.16275988
99%	0.16275988
95%	0.09563256
90%	0.05005051
75% Q3	0.03032897
50% Median	-0.00677133
25% Q1	-0.02444381
10%	-0.05994949
5%	-0.09436744
1%	-0.13724012
0% Min	-0.13724012

Extreme Observations				
-----Lowest-----		-----Highest-----		
Value	Obs	Value	Obs	
-0.1372401	16	0.0340483	22	
-0.0943674	2	0.0485837	20	
-0.0599495	14	0.0500505	13	
-0.0463500	6	0.0956326	1	
-0.0414163	19	0.1627599	15	

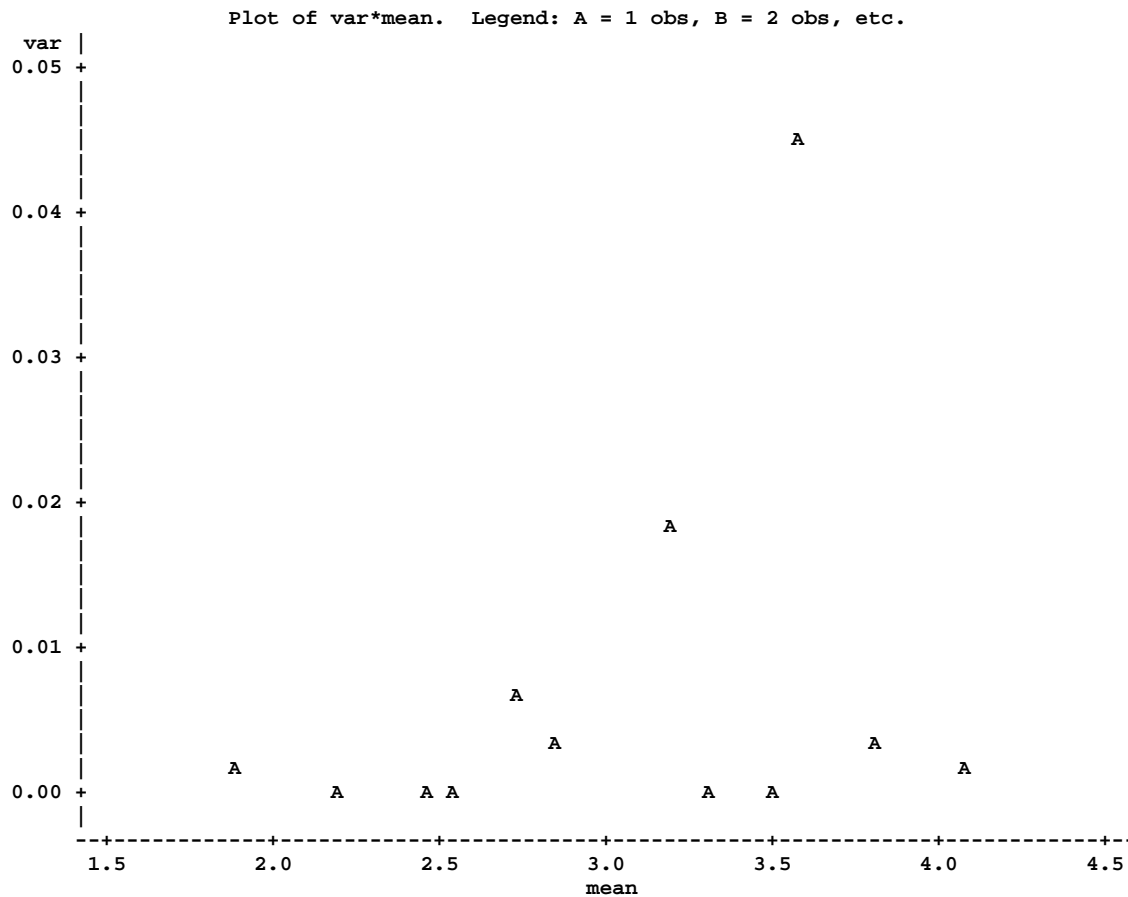


```

51      proc sort data=calcium; by plant leaf; run;
NOTE: There were 24 observations read from the data set WORK.CALCIUM.
NOTE: The data set WORK.CALCIUM has 24 observations and 4 variables.
NOTE: PROCEDURE SORT used:
      real time          0.04 seconds
      cpu time           0.04 seconds
52      OPTIONS PS=45 LS=88;
53      proc means data=calcium noprint; by plant leaf; var calcium;
54      output out=next1 n=n mean=mean var=var; run;
NOTE: There were 24 observations read from the data set WORK.CALCIUM.
NOTE: The data set WORK.NEXT1 has 12 observations and 7 variables.
NOTE: PROCEDURE MEANS used:
      real time          0.04 seconds
      cpu time           0.04 seconds
55      proc plot data=next1; plot var*mean;
56      TITLE3 'Variance/Mean plot for PROC MIXED - Nested Error';
57      run;
57      !      OPTIONS PS=256 LS=111;
NOTE: There were 12 observations read from the data set WORK.NEXT1.
NOTE: The PROCEDURE PLOT printed page 5.
NOTE: PROCEDURE PLOT used:
      real time          0.01 seconds
      cpu time           0.01 seconds

```

CALCIUM CONCENTRATION IN TURNIP LEAVES  
4 PLANTS, 3 LEAVES AND 2 SAMPLES OF 100 MG PER LEAF  
Variance/Mean plot for PROC MIXED - Nested Error



```

59      PROC GLM DATA=CALCIUM; CLASSES PLANT LEAF SAMPLE;
60      TITLE3 'Analysis OF Variance with GLM - Nested Error';
61      MODEL CALCIUM = PLANT LEAF(PLANT);
62      TEST H=PLANT E=LEAF(PLANT) / HTYPE=1 ETYPE=1;
63      RANDOM PLANT LEAF(PLANT);
64      RUN;

```

NOTE: TYPE I EMS not available without the E1 option.

```
64      !      QUIT;
```

NOTE: The PROCEDURE GLM printed pages 6-8.

NOTE: PROCEDURE GLM used:

```

      real time          0.08 seconds
      cpu time           0.08 seconds

```

#### CALCIUM CONCENTRATION IN TURNIP LEAVES

4 PLANTS, 3 LEAVES AND 2 SAMPLES OF 100 MG PER LEAF

Analysis OF Variance with GLM - Nested Error

The GLM Procedure

##### Class Level Information

Class	Levels	Values
PLANT	4	1 2 3 4
LEAF	3	1 2 3
SAMPLE	2	1 2

Number of observations 24

Dependent Variable: CALCIUM

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	10.19054583	0.92641326	139.22	<.0001
Error	12	0.07985000	0.00665417		
Corrected Total	23	10.27039583			

R-Square	Coeff Var	Root MSE	CALCIUM Mean
0.992225	2.708195	0.081573	3.012083

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PLANT	3	7.56034583	2.52011528	378.73	<.0001
LEAF(PLANT)	8	2.63020000	0.32877500	49.41	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PLANT	3	7.56034583	2.52011528	378.73	<.0001
LEAF(PLANT)	8	2.63020000	0.32877500	49.41	<.0001

##### Tests of Hypotheses Using the Type I MS for LEAF(PLANT) as an Error Term

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PLANT	3	7.56034583	2.52011528	7.67	0.0097

Source	Type III Expected Mean Square
PLANT	Var(Error) + 2 Var(LEAF(PLANT)) + 6 Var(PLANT)
LEAF(PLANT)	Var(Error) + 2 Var(LEAF(PLANT))

```

66      **EXAMPLE 3*****;
67      *** Example of nested design with unequal number      ***;
68      *** From Snedecor & Cochran, 1967 (pg 293)          ***;
69      *****;
70      OPTIONS PS=256 LS=111 NOCENTER NODATE NONUMBER;
71      DATA WHEAT; INFILE CARDS MISSEVER;
72      INPUT YIELD FIELD FARM DISTRICT $;
73      TITLE1 'Wheat yields (g / 0.00009 acre)';
74      TITLE2 'CRD with unequal experimental and sampling units)';
75      CARDS;
    
```

NOTE: The data set WORK.WHEAT has 36 observations and 4 variables.

NOTE: DATA statement used:  
 real time 0.03 seconds  
 cpu time 0.03 seconds

```

75      ! RUN;
112     ;
113     PROC PRINT; TITLE3 'RAW DATA LISTING'; RUN;
    
```

NOTE: There were 36 observations read from the data set WORK.WHEAT.

NOTE: The PROCEDURE PRINT printed page 9.

NOTE: PROCEDURE PRINT used:  
 real time 0.01 seconds  
 cpu time 0.01 seconds

Wheat yields (g / 0.00009 acre)  
 CRD with unequal number of experimental and sampling units)  
 RAW DATA LISTING

Obs	YIELD	FIELD	FARM		18	39	1	6	D
DISTRICT					19	20	1	7	D
1	23	1	1	A	20	24	1	8	D
2	19	2	1	A	21	36	1	9	D
3	31	1	2	A	22	25	1	1	E
4	37	2	2	A	23	33	2	1	E
5	33	1	1	B	24	28	1	1	F
6	29	2	1	B	25	31	2	1	F
7	29	1	2	B	26	25	1	2	F
8	36	1	1	C	27	42	2	2	F
9	29	2	1	C	28	32	1	3	F
10	33	3	1	C	29	36	2	3	F
11	11	1	1	D	30	41	1	4	F
12	21	2	1	D	31	35	1	5	F
13	23	1	2	D	32	16	1	6	F
14	18	2	2	D	33	30	1	7	F
15	33	1	3	D	34	40	1	8	F
16	23	1	4	D	35	32	1	9	F
17	26	1	5	D	36	44	1	10	F

```

114     PROC MIXED DATA=WHEAT cl COVTEST; CLASSES FIELD FARM DISTRICT;
115     TITLE3 'ANOVA with PROC MIXED - unequal sized nested Errors';
116     MODEL YIELD = / htype=1 DDFM=Satterthwaite outp=ResidDataP;
117     RANDOM DISTRICT FARM(DISTRICT);
118     RUN;
    
```

NOTE: Convergence criteria met.

NOTE: The data set WORK.RESIDDATAP has 36 observations and 11 variables.

NOTE: The PROCEDURE MIXED printed page 10.

NOTE: PROCEDURE MIXED used:  
 real time 0.16 seconds  
 cpu time 0.14 seconds

```

118     ! QUIT;
    
```

Wheat yields (g / 0.00009 acre)

CRD with unequal number of experimental and sampling units)

ANOVA with PROC MIXED - unequal sized nested Errors

The Mixed Procedure

#### Model Information

Data Set	WORK.WHEAT
Dependent Variable	YIELD
Covariance Structure	Variance Components
Estimation Method	REML
Residual Variance Method	Profile
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Satterthwaite

#### Class Level Information

Class	Levels	Values
FIELD	3	1 2 3
FARM	10	1 2 3 4 5 6 7 8 9 10
DISTRICT	6	A B C D E F

#### Dimensions

Covariance Parameters	3
Columns in X	1
Columns in Z	31
Subjects	1
Max Obs Per Subject	36
Observations Used	36
Observations Not Used	0
Total Observations	36

#### Iteration History

Iteration	Evaluations	-2 Res	Log Like	Criterion
0	1	246.55907914		
1	3	243.48928235		0.00694802
2	2	242.71561388		0.00192010
3	1	242.51666454		0.00017057
4	1	242.50058397		0.00000150
5	1	242.50044987		0.00000000

Convergence criteria met.

#### Covariance Parameter Estimates

Cov Parm	Estimate	Standard Error	Z	Pr Z	Alpha	Lower	Upper
DISTRICT	6.3148	9.1543	0.69	0.2452	0.05	1.2289	9022.02
FARM(DISTRICT)	26.0928	18.6720	1.40	0.0811	0.05	9.2820	223.79
Residual	29.8395	13.2217	2.26	0.0120	0.05	14.6468	90.6929

#### Fit Statistics

-2 Res Log Likelihood	242.5
AIC (smaller is better)	248.5
AICC (smaller is better)	249.3
BIC (smaller is better)	247.9

```

119     PROC MIXED DATA=WHEAT cl COVTEST method=TYPE1;
120     CLASSES FIELD FARM DISTRICT;
121     TITLE3 'ANOVA with Type I SS - unequal sized nested Errors';
122     MODEL YIELD = / htype=1 DDFM=Satterthwaite outp=ResidDataP;
123     RANDOM DISTRICT FARM(DISTRICT);
124     RUN;

```

NOTE: Estimated G matrix is not positive definite.

NOTE: The data set WORK.RESIDDATAP has 36 observations and 11 variables.



NOTE: The PROCEDURE MIXED printed page 11.

NOTE: PROCEDURE MIXED used:

real time 0.17 seconds  
cpu time 0.17 seconds

124 ! QUIT;

Wheat yields (g / 0.00009 acre)

CRD with unequal number of experimental and sampling units)

ANOVA with Type I SS - unequal sized nested Errors

The Mixed Procedure

#### Model Information

Data Set WORK.WHEAT  
Dependent Variable YIELD  
Covariance Structure Variance Components  
Estimation Method Type 1  
Residual Variance Method Factor  
Fixed Effects SE Method Model-Based  
Degrees of Freedom Method Satterthwaite

#### Class Level Information

Class	Levels	Values
FIELD	3	1 2 3
FARM	10	1 2 3 4 5 6 7 8 9 10
DISTRICT	6	A B C D E F

#### Dimensions

Covariance Parameters	3
Columns in X	1
Columns in Z	31
Subjects	1
Max Obs Per Subject	36
Observations Used	36
Observations Not Used	0
Total Observations	36

#### Type 1 Analysis of Variance

Source	DF	Sum of Squares	Mean Square	Expected Mean Square
DISTRICT	5	461.422106	92.284421	Var(Residual) + 1.965 Var(FARM(DISTRICT)) + 5.3778 Var(DISTRICT)
FARM(DISTRICT)	19	1349.383450	71.020182	Var(Residual) + 1.2899 Var(FARM(DISTRICT))
Residual	11	310.166667	28.196970	Var(Residual)

#### Type 1 Analysis of Variance

Source	Error Term	DF	F Value	Pr > F
DISTRICT	1.5234 MS(FARM(DISTRICT)) - 0.5234 MS(Residual)	13.729	0.99	0.4601
FARM(DISTRICT)	MS(Residual)	11	2.52	0.0597
Residual	.	.	.	.

#### Covariance Parameter Estimates

Cov Parm	Estimate	Standard Error	Z	Pr Z	Alpha	Lower	Upper
DISTRICT	-0.2137	3.7702	-0.06	0.9548	0.05	-7.6031	7.1757
FARM(DISTRICT)	33.1988	24.0001	1.38	0.1666	0.05	-13.8405	80.2380
Residual	28.1970	13.3949	2.11	0.0176	0.05	14.1499	81.2859

#### Fit Statistics

-2 Res Log Likelihood	243.6
AIC (smaller is better)	249.6
AICC (smaller is better)	250.4
BIC (smaller is better)	249.0

```

125      proc univariate data=ResidDataP plot normal; var resid;
126          TITLE3 'Univariate analysis for PROC MIXED - unequal nested
Errors';
127      run;

```

NOTE: The PROCEDURE UNIVARIATE printed page 12.

NOTE: PROCEDURE UNIVARIATE used:

```

      real time          0.03 seconds
      cpu time           0.03 seconds

```

Wheat yields (g / 0.00009 acre)

CRD with unequal number of experimental and sampling units)

Univariate analysis for PROC MIXED - unequal nested Errors

The UNIVARIATE Procedure

Variable: Resid

Moments			
N	36	Sum Weights	36
Mean	0	Sum Observations	0
Std Deviation	4.11793027	Variance	16.9573497
Skewness	-0.059663	Kurtosis	-0.1028235
Uncorrected SS	593.50724	Corrected SS	593.50724
Coeff Variation	.	Std Error Mean	0.68632171

Basic Statistical Measures			
Location		Variability	
Mean	0.00000	Std Deviation	4.11793
Median	-0.07467	Variance	16.95735
Mode	.	Range	18.79915
		Interquartile Range	5.91856

Tests for Location: Mu0=0

Test	-Statistic-	-----p Value-----
Student's t	t 0	Pr >  t  1.0000
Sign	M 0	Pr >=  M  1.0000
Signed Rank	S 1	Pr >=  S  0.9877

Tests for Normality

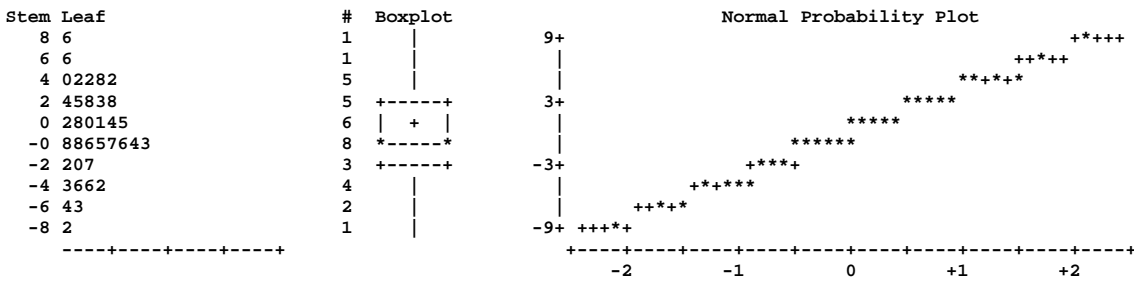
Test	--Statistic--	-----p Value-----
Shapiro-Wilk	W 0.994152	Pr < W 0.9994
Kolmogorov-Smirnov	D 0.053846	Pr > D >0.1500
Cramer-von Mises	W-Sq 0.015867	Pr > W-Sq >0.2500
Anderson-Darling	A-Sq 0.114678	Pr > A-Sq >0.2500

Quantiles (Definition 5)

Quantile	Estimate
100% Max	9.647650
99%	9.647650
95%	6.590515
90%	4.753452
75% Q3	3.042826
50% Median	-0.074667
25% Q1	-2.875738
10%	-5.310128
5%	-7.352350
1%	-9.151499
0% Min	-9.151499

Extreme Observations

-----Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
-9.15150	11	4.24802	4
-7.35235	26	4.75345	34
-6.26893	32	5.21272	30
-5.31013	14	6.59052	36
-4.62705	2	9.64765	27



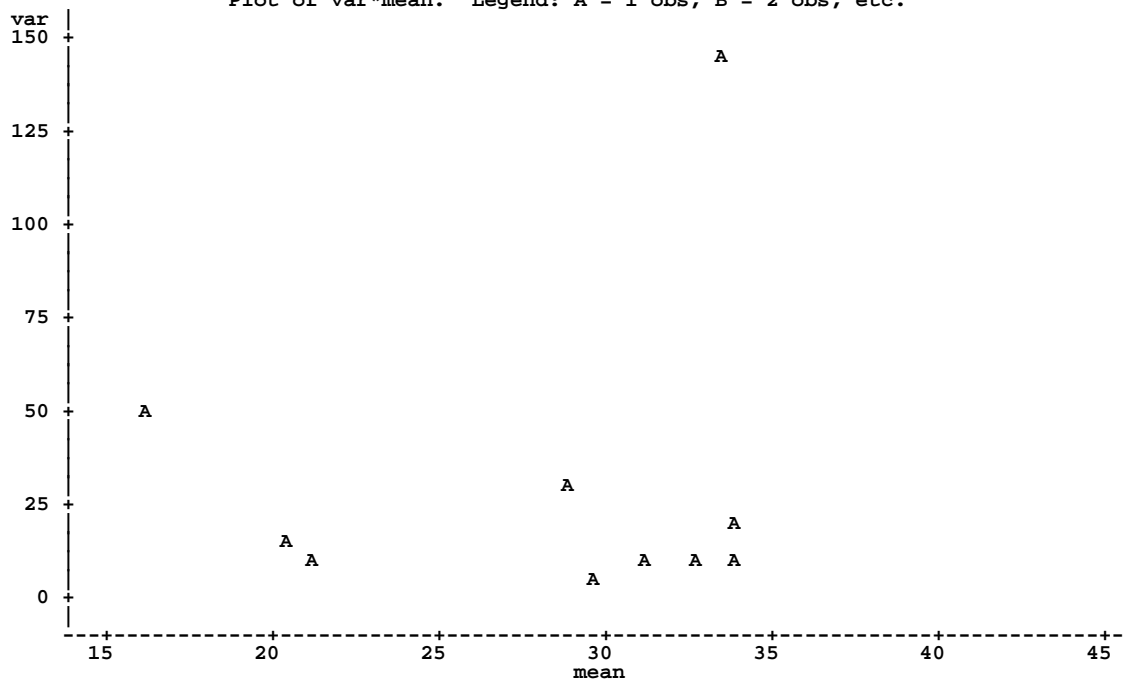
```

128      proc sort data=WHEAT; by district farm; run;
NOTE: There were 36 observations read from the data set WORK.WHEAT.
NOTE: The data set WORK.WHEAT has 36 observations and 4 variables.
NOTE: PROCEDURE SORT used:
      real time          0.03 seconds
      cpu time           0.03 seconds

128      !                                     OPTIONS PS=45 LS=88;
129      proc means data=WHEAT noprint; by district farm; var yield;
130      output out=next2 n=n mean=mean var=var; run;
NOTE: There were 36 observations read from the data set WORK.WHEAT.
NOTE: The data set WORK.NEXT2 has 25 observations and 7 variables.
NOTE: PROCEDURE MEANS used:
      real time          0.04 seconds
      cpu time           0.04 seconds

131      proc plot data=next2; plot var*mean;
132      TITLE3 'Variance/Mean plot for PROC MIXED - unequal nested
Errors';
133      run; OPTIONS PS=256 LS=111;
NOTE: There were 25 observations read from the data set WORK.NEXT2.
NOTE: The PROCEDURE PLOT printed page 13.
NOTE: PROCEDURE PLOT used:
      real time          0.02 seconds
      cpu time           0.02 seconds
    
```

Wheat yields (g / 0.00009 acre)  
 CRD with unequal number of experimental and sampling units)  
 Variance/Mean plot for PROC MIXED - unequal nested Errors  
 Plot of var\*mean. Legend: A = 1 obs, B = 2 obs, etc.



NOTE: 15 obs had missing values.

```

135      PROC GLM DATA=WHEAT; CLASSES FIELD FARM DISTRICT;
136          TITLE3 'ANOVA with GLM - unequal sized nested Errors';
137          MODEL YIELD = DISTRICT FARM(DISTRICT);
138          TEST H=DISTRICT E=FARM(DISTRICT) / HTYPE=1 ETYPE=1;
139          RANDOM DISTRICT FARM(DISTRICT) / TEST;
140      RUN;

```

NOTE: TYPE I EMS not available without the E1 option.

```
140      !      QUIT;
```

NOTE: The PROCEDURE GLM printed pages 14-17.

NOTE: PROCEDURE GLM used:

```

      real time      0.08 seconds
      cpu time       0.08 seconds

```

Wheat yields (g / 0.00009 acre)

CRD with unequal number of experimental and sampling units)

ANOVA with GLM - unequal sized nested Errors

The GLM Procedure

```

          Class Level Information
Class      Levels      Values
FIELD              3      1 2 3
FARM              10      1 2 3 4 5 6 7 8 9 10
DISTRICT           6      A B C D E F
Number of observations      36

```

Dependent Variable: YIELD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	24	1810.805556	75.450231	2.68	0.0459
Error	11	310.166667	28.196970		
Corrected Total	35	2120.972222			

R-Square	Coeff Var	Root MSE	YIELD Mean
0.853762	17.98334	5.310082	29.52778

Source	DF	Type I SS	Mean Square	F Value	Pr > F
DISTRICT	5	461.422106	92.284421	3.27	0.0471
FARM(DISTRICT)	19	1349.383450	71.020182	2.52	0.0597

Source	DF	Type III SS	Mean Square	F Value	Pr > F
DISTRICT	5	324.470997	64.894199	2.30	0.1158
FARM(DISTRICT)	19	1349.383450	71.020182	2.52	0.0597

Tests of Hypotheses Using the Type I MS for FARM(DISTRICT) as an Error Term

Source	DF	Type I SS	Mean Square	F Value	Pr > F
DISTRICT	5	461.4221057	92.2844211	1.30	0.3056

Source	Type III Expected Mean Square
DISTRICT	Var(Error) + 1.8302 Var(FARM(DISTRICT)) + 5.0601 Var(DISTRICT)
FARM(DISTRICT)	Var(Error) + 1.2899 Var(FARM(DISTRICT))

Tests of Hypotheses for Random Model Analysis of Variance

Dependent Variable: YIELD

Source	DF	Type III SS	Mean Square	F Value	Pr > F
DISTRICT	5	324.470997	64.894199	0.73	0.6126
Error	14.464	1286.672238	88.958186		
Error: 1.4189*MS(FARM(DISTRICT)) - 0.4189*MS(Error)					

Source	DF	Type III SS	Mean Square	F Value	Pr > F
FARM(DISTRICT)	19	1349.383450	71.020182	2.52	0.0597
Error: MS(Error)	11	310.166667	28.196970		

```

143      **EXAMPLE 4*****;
144      *** Example of RBD ***;
145      *** From Snedecor & Cochran, 1980 (pg 256) ***;
146      *****;
147      OPTIONS PS=256 LS=111 NOCENTER NODATE NONUMBER;
148      DATA SOYBEAN; INFILE CARDS MISSEVER;
149          INPUT treatment $ BLOCK FAILURES;
150          TITLE1 'FAILURES TO GERMINATE OF SOYBEAN PLANTS';
151          TITLE2 '4 TREATMENTS AND A CONTROL, 5 BLOCKS';
152      CARDS;

```

NOTE: The data set WORK.SOYBEAN has 25 observations and 3 variables.

NOTE: DATA statement used:

```

real time      0.03 seconds
cpu time       0.03 seconds

```

```

152      !          RUN;

```

```

178      ;

```

```

179      PROC PRINT; TITLE3 'RAW DATA LISTING'; RUN;

```

NOTE: There were 25 observations read from the data set WORK.SOYBEAN.

NOTE: The PROCEDURE PRINT printed page 18.

NOTE: PROCEDURE PRINT used:

```

real time      0.01 seconds
cpu time       0.01 seconds

```

```

FAILURES TO GERMINATE OF SOYBEAN PLANTS
4 TREATMENTS AND A CONTROL, 5 BLOCKS
RAW DATA LISTING

```

Obs	treatment	BLOCK		13	SPERGON	3	9
FAILURES							
1	CHECK	1	8	14	SPERGON	4	8
2	CHECK	2	10	15	SPERGON	5	10
3	CHECK	3	12	16	SEMESAN	1	3
4	CHECK	4	13	17	SEMESAN	2	5
5	CHECK	5	11	18	SEMESAN	3	9
6	ARASAN	1	2	19	SEMESAN	4	10
7	ARASAN	2	6	20	SEMESAN	5	6
8	ARASAN	3	7	21	FERMATE	1	9
9	ARASAN	4	11	22	FERMATE	2	7
10	ARASAN	5	5	23	FERMATE	3	5
11	SPERGON	1	4	24	FERMATE	4	5
12	SPERGON	2	10	25	FERMATE	5	3

```

180      PROC MIXED DATA=SOYBEAN c1 COVTEST; CLASSES treatment BLOCK;
181          TITLE3 'ANOVA with PROC MIXED - RBD without reps';
182          MODEL FAILURES = treatment / htype=3 DDFM=Satterthwaite outp=ResidDataP;
183          RANDOM BLOCK;
184          lsmeans treatment / pdiff adjust=tukey;
185      RUN;

```

NOTE: Convergence criteria met.

NOTE: The data set WORK.RESIDDATA P has 25 observations and 10 variables.

NOTE: The PROCEDURE MIXED printed page 19.

NOTE: PROCEDURE MIXED used:

```

real time      0.20 seconds
cpu time       0.20 seconds

```

```

185      !          QUIT;

```

## FAILURES TO GERMINATE OF SOYBEAN PLANTS

4 TREATMENTS AND A CONTROL, 5 BLOCKS

ANOVA with PROC MIXED - RBD without reps

The Mixed Procedure

## Model Information

Data Set	WORK.SOYBEAN
Dependent Variable	FAILURES
Covariance Structure	Variance Components
Estimation Method	REML
Residual Variance Method	Profile
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Satterthwaite

## Class Level Information

Class	Levels	Values
treatment	5	ARASAN CHECK FERMATE SEMESAN SPERGON
BLOCK	5	1 2 3 4 5

## Dimensions

Covariance Parameters	2
Columns in X	6
Columns in Z	5
Subjects	1
Max Obs Per Subject	25
Observations Used	25
Observations Not Used	0
Total Observations	25

## Iteration History

Iteration	Evaluations	-2 Res Log Like	Criterion
0	1	103.20192033	
1	1	101.90681043	0.00000000

Convergence criteria met.

## Covariance Parameter Estimates

Cov Parm	Estimate	Standard Error	Z	Pr >  Z	Alpha	Lower	Upper
BLOCK	1.4100	1.8032	0.78	0.2171	0.05	0.3075	430.52
Residual	5.4100	1.9127	2.83	0.0023	0.05	3.0008	12.5310

## Fit Statistics

-2 Res Log Likelihood	101.9
AIC (smaller is better)	105.9
AICC (smaller is better)	106.6
BIC (smaller is better)	105.1

## Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
treatment	4	16	3.87	0.0219

## Least Squares Means

Effect	treatment	Estimate	Standard Error	DF	t Value	Pr >  t
treatment	ARASAN	6.2000	1.1679	17.1	5.31	<.0001
treatment	CHECK	10.8000	1.1679	17.1	9.25	<.0001
treatment	FERMATE	5.8000	1.1679	17.1	4.97	0.0001
treatment	SEMESAN	6.6000	1.1679	17.1	5.65	<.0001
treatment	SPERGON	8.2000	1.1679	17.1	7.02	<.0001

Effect	treatment	_treatment	Differences of Least Squares Means		DF	t Value	Pr >  t	Adjustment	Adj P
			Estimate	Error Standard					
treatment	ARASAN	CHECK	-4.6000	1.4711	16	-3.13	0.0065	Tukey-Kramer	0.0443
treatment	ARASAN	FERMATE	0.4000	1.4711	16	0.27	0.7892	Tukey-Kramer	0.9987
treatment	ARASAN	SEMESAN	-0.4000	1.4711	16	-0.27	0.7892	Tukey-Kramer	0.9987
treatment	ARASAN	SPERGON	-2.0000	1.4711	16	-1.36	0.1928	Tukey-Kramer	0.6602
treatment	CHECK	FERMATE	5.0000	1.4711	16	3.40	0.0037	Tukey-Kramer	0.0261
treatment	CHECK	SEMESAN	4.2000	1.4711	16	2.86	0.0115	Tukey-Kramer	0.0740
treatment	CHECK	SPERGON	2.6000	1.4711	16	1.77	0.0962	Tukey-Kramer	0.4242
treatment	FERMATE	SEMESAN	-0.8000	1.4711	16	-0.54	0.5941	Tukey-Kramer	0.9812
treatment	FERMATE	SPERGON	-2.4000	1.4711	16	-1.63	0.1223	Tukey-Kramer	0.4999
treatment	SEMESAN	SPERGON	-1.6000	1.4711	16	-1.09	0.2929	Tukey-Kramer	0.8102

```
186      proc univariate data=ResidDataP plot normal; var resid;
187          TITLE3 'Univariate analysis for PROC MIXED - RBD without reps';
188      run;
```

NOTE: The PROCEDURE UNIVARIATE printed page 20.

NOTE: PROCEDURE UNIVARIATE used:

```
real time      0.03 seconds
cpu time      0.03 seconds
```

FAILURES TO GERMINATE OF SOYBEAN PLANTS  
 4 TREATMENTS AND A CONTROL, 5 BLOCKS  
 Univariate analysis for PROC MIXED - RBD without reps  
 The UNIVARIATE Procedure  
 Variable: Resid

Moments			
N	25	Sum Weights	25
Mean	0	Sum Observations	0
Std Deviation	1.99954014	Variance	3.99816078
Skewness	0.48805915	Kurtosis	-0.3291607
Uncorrected SS	95.9558587	Corrected SS	95.9558587
Coeff Variation	.	Std Error Mean	0.39990803

Basic Statistical Measures			
Location		Variability	
Mean	0.00000	Std Deviation	1.99954
Median	-0.24526	Variance	3.99816
Mode	.	Range	7.40000
		Interquartile Range	2.64205

Tests for Location: Mu0=0				
Test	-Statistic-	-----p Value-----		
Student's t	t	0	Pr >  t	1.0000
Sign	M	-0.5	Pr >=  M	1.0000
Signed Rank	S	-8.5	Pr >=  S	0.8244

Tests for Normality				
Test	--Statistic--	-----p Value-----		
Shapiro-Wilk	W	0.963523	Pr < W	0.4890
Kolmogorov-Smirnov	D	0.103754	Pr > D	>0.1500
Cramer-von Mises	W-Sq	0.033262	Pr > W-Sq	>0.2500
Anderson-Darling	A-Sq	0.249495	Pr > A-Sq	>0.2500

Quantiles (Definition 5)

Quantile	Estimate
100% Max	4.512681
99%	4.512681
95%	3.736276
90%	2.336276
75% Q3	1.154735
50% Median	-0.245265

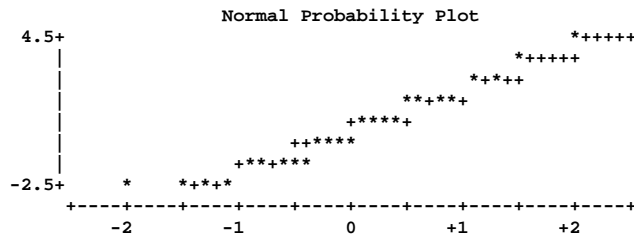
25% Q1           -1.487319  
 10%             -2.505778  
 5%              -2.887319  
 1%              -2.887319  
 0% Min         -2.887319

Extreme Observations

-----Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
-2.88732	11	1.90209	18
-2.88732	6	2.09422	15
-2.50578	25	2.33628	19
-2.28732	16	3.73628	9
-1.86372	24	4.51268	21

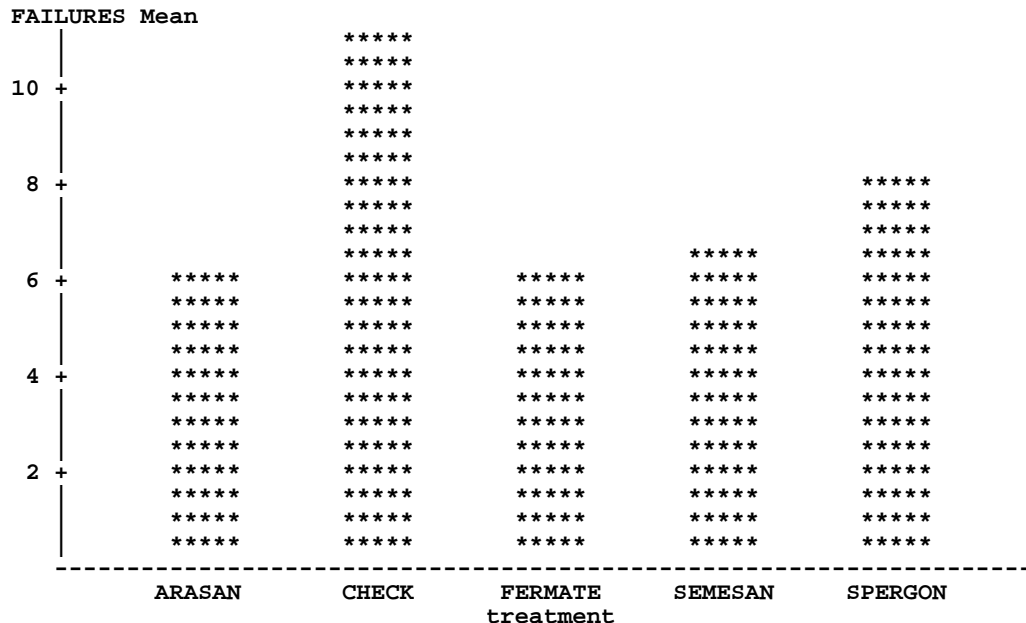
```
Stem Leaf
 4 5
 3 7
 2 13
 1 1289
 0 3357
-0 9832
-1 96533
-2 9953
```

```
# Boxplot
 1 |
 2 |
 4 +-----+
 4 | + |
 4 *-----*
 5 +-----+
 4 |
```



```
189          PROC CHART DATA=SOYBEAN; OPTIONS PS=45 LS=88;
190              TITLE3 'Histogram of MIXED analysis - RBD without reps';
191              VBAR treatment / SUMVAR=FAILURES TYPE=MEAN; RUN;
NOTE: The PROCEDURE CHART printed page 21.
NOTE: PROCEDURE CHART used:
      real time          0.00 seconds
      cpu time           0.00 seconds
191          !                                OPTIONS PS=256 LS=111;
```

FAILURES TO GERMINATE OF SOYBEAN PLANTS  
 4 TREATMENTS AND A CONTROL, 5 BLOCKS  
 Histogram of MIXED analysis - RBD without reps





```

193      PROC GLM DATA=SOYBEAN; CLASSES treatment BLOCK;
194      TITLE3 'ANOVA with PROC GLM - RBD without reps';
195      MODEL FAILURES = treatment BLOCK;
196      RANDOM treatment BLOCK / TEST;
197      means treatment / tukey;
198      lsmeans treatment / pdiff stderr adjust=tukey;
199      RUN;

```

NOTE: TYPE I EMS not available without the E1 option.

NOTE: Means from the MEANS statement are not adjusted for other terms in the model. For adjusted means, use the LSMEANS statement.

```
199      !      QUIT;
```

NOTE: The PROCEDURE GLM printed pages 22-27.

NOTE: PROCEDURE GLM used:

```

      real time      0.21 seconds
      cpu time       0.15 seconds

```

FAILURES TO GERMINATE OF SOYBEAN PLANTS  
4 TREATMENTS AND A CONTROL, 5 BLOCKS  
ANOVA with PROC GLM - RBD without reps  
The GLM Procedure

Class Level Information

Class	Levels	Values
treatment	5	ARASAN CHECK FERMATE SEMESAN SPERGON
BLOCK	5	1 2 3 4 5

Number of observations 25

FAILURES TO GERMINATE OF SOYBEAN PLANTS  
4 TREATMENTS AND A CONTROL, 5 BLOCKS  
ANOVA with PROC GLM - RBD without reps  
The GLM Procedure

Dependent Variable: FAILURES

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	133.6800000	16.7100000	3.09	0.0262
Error	16	86.5600000	5.4100000		
Corrected Total	24	220.2400000			

R-Square	Coeff Var	Root MSE	FAILURES Mean
0.606974	30.93006	2.325941	7.520000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
treatment	4	83.84000000	20.96000000	3.87	0.0219
BLOCK	4	49.84000000	12.46000000	2.30	0.1032

Source	DF	Type III SS	Mean Square	F Value	Pr > F
treatment	4	83.84000000	20.96000000	3.87	0.0219
BLOCK	4	49.84000000	12.46000000	2.30	0.1032

Source	Type III Expected Mean Square
treatment	Var(Error) + 5 Var(treatment)
BLOCK	Var(Error) + 5 Var(BLOCK)

## FAILURES TO GERMINATE OF SOYBEAN PLANTS

4 TREATMENTS AND A CONTROL, 5 BLOCKS

ANOVA with PROC GLM - RBD without reps

The GLM Procedure

## Tests of Hypotheses for Random Model Analysis of Variance

Dependent Variable: FAILURES

Source	DF	Type III SS	Mean Square	F Value	Pr > F
treatment	4	83.840000	20.960000	3.87	0.0219
BLOCK	4	49.840000	12.460000	2.30	0.1032
Error: MS(Error)	16	86.560000	5.410000		

## Tukey's Studentized Range (HSD) Test for FAILURES

NOTE: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than REGWQ.

Alpha	0.05
Error Degrees of Freedom	16
Error Mean Square	5.41
Critical Value of Studentized Range	4.33269
Minimum Significant Difference	4.5068

Means with the same letter are not significantly different.

Tukey Grouping	Mean	N	treatment
A	10.800	5	CHECK
A			
B A	8.200	5	SPERGON
B A			
B A	6.600	5	SEMESAN
B			
B	6.200	5	ARASAN
B			
B	5.800	5	FERMATE

## Least Squares Means

Adjustment for Multiple Comparisons: Tukey

treatment	FAILURES LSMEAN	Standard Error	Pr >  t	LSMEAN Number
ARASAN	6.2000000	1.0401923	<.0001	1
CHECK	10.8000000	1.0401923	<.0001	2
FERMATE	5.8000000	1.0401923	<.0001	3
SEMESAN	6.6000000	1.0401923	<.0001	4
SPERGON	8.2000000	1.0401923	<.0001	5

## Least Squares Means for effect treatment

Pr &gt; |t| for H0: LSmean(i)=LSmean(j)

Dependent Variable: FAILURES

i/j	1	2	3	4	5
1		0.0443	0.9987	0.9987	0.6602
2	0.0443		0.0261	0.0740	0.4242
3	0.9987	0.0261		0.9812	0.4999
4	0.9987	0.0740	0.9812		0.8102
5	0.6602	0.4242	0.4999	0.8102	

```

203      **EXAMPLE 5*****;
204      *** Example of RBD with sampling error          ***;
205      *** From Snedecor & Cochran, 1980 (pg 267)    ***;
206      *****;
207      OPTIONS PS=256 LS=111 NOCENTER NODATE NONUMBER;
208      DATA FUMIGANT; INFILE CARDS MISSEVER;
209          INPUT FUMIGANT $ BLOCK $ W1 W2 W3 W4;
210          TITLE1 'Number of wire worms found for 2 fumigants and a control';
211          TITLE2 'Fumigants are C and S, control is 0, 5 BLOCKS';
212          REP=1; WORMS=W1; LWORMS=LOG(WORMS+1); OUTPUT;
213          REP=2; WORMS=W2; LWORMS=LOG(WORMS+1); OUTPUT;
214          REP=3; WORMS=W3; LWORMS=LOG(WORMS+1); OUTPUT;
215          REP=4; WORMS=W4; LWORMS=LOG(WORMS+1); OUTPUT;
216          KEEP FUMIGANT BLOCK REP WORMS LWORMS;
217      CARDS;

```

NOTE: The data set WORK.FUMIGANT has 60 observations and 5 variables.

NOTE: DATA statement used:

```

real time      0.04 seconds
cpu time       0.04 seconds

```

```
217      !          RUN;
```

```
233      ;
```

```
234      PROC PRINT; TITLE3 'RAW DATA LISTING'; RUN;
```

NOTE: There were 60 observations read from the data set WORK.FUMIGANT.

NOTE: The PROCEDURE PRINT printed page 28.

NOTE: PROCEDURE PRINT used:

```

real time      0.01 seconds
cpu time       0.01 seconds

```

Number of wire worms found for 2 fumigants and a control

Fumigants are C and S, control is 0, 5 BLOCKS

RAW DATA LISTING

Obs	FUMIGANT	BLOCK	REP	WORMS	LWORMS						
						30	S	III	2	9	2.30259
						31	S	III	3	3	1.38629
1	C	I	1	5	1.79176	32	S	III	4	7	2.07944
2	C	I	2	4	1.60944	33	S	IV	1	6	1.94591
3	C	I	3	5	1.79176	34	S	IV	2	4	1.60944
4	C	I	4	2	1.09861	35	S	IV	3	8	2.19722
5	C	II	1	0	0.00000	36	S	IV	4	4	1.60944
6	C	II	2	9	2.30259	37	S	V	1	2	1.09861
7	C	II	3	3	1.38629	38	S	V	2	9	2.30259
8	C	II	4	3	1.38629	39	S	V	3	7	2.07944
9	C	III	1	4	1.60944	40	S	V	4	3	1.38629
10	C	III	2	4	1.60944	41	0	I	1	12	2.56495
11	C	III	3	3	1.38629	42	0	I	2	20	3.04452
12	C	III	4	9	2.30259	43	0	I	3	8	2.19722
13	C	IV	1	7	2.07944	44	0	I	4	8	2.19722
14	C	IV	2	3	1.38629	45	0	II	1	7	2.07944
15	C	IV	3	5	1.79176	46	0	II	2	4	1.60944
16	C	IV	4	12	2.56495	47	0	II	3	4	1.60944
17	C	V	1	4	1.60944	48	0	II	4	5	1.79176
18	C	V	2	9	2.30259	49	0	III	1	9	2.30259
19	C	V	3	8	2.19722	50	0	III	2	6	1.94591
20	C	V	4	6	1.94591	51	0	III	3	7	2.07944
21	S	I	1	5	1.79176	52	0	III	4	11	2.48491
22	S	I	2	5	1.79176	53	0	IV	1	12	2.56495
23	S	I	3	1	0.69315	54	0	IV	2	22	3.13549
24	S	I	4	2	1.09861	55	0	IV	3	17	2.89037
25	S	II	1	6	1.94591	56	0	IV	4	13	2.63906
26	S	II	2	4	1.60944	57	0	V	1	7	2.07944
27	S	II	3	5	1.79176	58	0	V	2	8	2.19722
28	S	II	4	4	1.60944	59	0	V	3	5	1.79176
29	S	III	1	2	1.09861	60	0	V	4	9	2.30259

```

235      PROC mixed DATA=FUMIGANT c1 COVTEST; CLASSES FUMIGANT BLOCK REP;
236          TITLE3 'ANOVA with PROC MIXED - RBD with reps';
237          MODEL WORMS = FUMIGANT / htype=3 DDFM=Satterthwaite outp=ResidDataP outpM=ResidDataPM;
238          RANDOM BLOCK FUMIGANT*BLOCK;
239          lsmeans fumigant / pdiff ADJUST=DUNNETT diff=controll('0');
240          lsmeans fumigant / pdiff ADJUST=tukey;
241      RUN;
NOTE: Convergence criteria met.
NOTE: The data set WORK.RESIDDATAP has 60 observations and 12 variables.
NOTE: The data set WORK.RESIDDATAPM has 60 observations and 12 variables.
NOTE: The PROCEDURE MIXED printed page 29.
NOTE: PROCEDURE MIXED used:
      real time          0.22 seconds
      cpu time           0.22 seconds
241      !      QUIT;
  
```

Number of wire worms found for 2 fumigants and a control  
 Fumigants are C and S, control is 0, 5 BLOCKS  
 ANOVA with PROC MIXED - RBD with reps

The Mixed Procedure

Model Information	
Data Set	WORK.FUMIGANT
Dependent Variable	WORMS
Covariance Structure	Variance Components
Estimation Method	REML
Residual Variance Method	Profile
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Satterthwaite

Class Level Information		
Class	Levels	Values
FUMIGANT	3	0 C S
BLOCK	5	I II III IV V
REP	4	1 2 3 4

Dimensions

Covariance Parameters	3
Columns in X	4
Columns in Z	20
Subjects	1
Max Obs Per Subject	60
Observations Used	60
Observations Not Used	0
Total Observations	60

Iteration History				
Iteration	Evaluations	-2 Res Log Like	Criterion	
0	1	318.17726625		
1	1	310.27325992	0.00000000	

Convergence criteria met.

Covariance Parameter Estimates

Cov Parm	Estimate	Standard Error	Z Value	Pr >  Z	Alpha	Lower	Upper
BLOCK	1.1052	2.4502	0.45	0.3260	0.05	0.1473	25730931
FUMIGANT*BLOCK	3.8559	3.1035	1.24	0.1070	0.05	1.2517	50.5437
Residual	9.1056	1.9196	4.74	<.0001	0.05	6.2643	14.4450

Fit Statistics

-2 Res Log Likelihood	310.3
AIC (smaller is better)	316.3
AICC (smaller is better)	316.7
BIC (smaller is better)	315.1

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
FUMIGANT	2	8	5.98	0.0258

Least Squares Means  
 Standard

Effect	FUMIGANT	Estimate	Error	DF	t Value	Pr >  t
FUMIGANT	0	9.7000	1.2031	11.5	8.06	<.0001
FUMIGANT	C	5.2500	1.2031	11.5	4.36	0.0010
FUMIGANT	S	4.8000	1.2031	11.5	3.99	0.0020
FUMIGANT	0	9.7000	1.2031	11.5	8.06	<.0001
FUMIGANT	C	5.2500	1.2031	11.5	4.36	0.0010
FUMIGANT	S	4.8000	1.2031	11.5	3.99	0.0020

Differences of Least Squares Means  
 Standard

Effect	FUMIGANT	_FUMIGANT	Estimate	Error	DF	t Value	Tails	Pr t	Adjustment	Adj P
FUMIGANT	0	C	4.4500	1.5662	8	2.84	Upper	0.0109	Dunnett-Hsu	0.0194
FUMIGANT	0	S	4.9000	1.5662	8	3.13	Upper	0.0070	Dunnett-Hsu	0.0126
FUMIGANT	0	C	4.4500	1.5662	8	2.84	Both	0.0218	Tukey-Kramer	0.0512
FUMIGANT	0	S	4.9000	1.5662	8	3.13	Both	0.0140	Tukey-Kramer	0.0336
FUMIGANT	C	S	0.4500	1.5662	8	0.29	Both	0.7812	Tukey-Kramer	0.9558

```
242      proc print data=residdatap; TITLE4 'Output from the OUTP option';
run;
NOTE: There were 60 observations read from the data set WORK.RESIDDATAP.
NOTE: The PROCEDURE PRINT printed page 30.
NOTE: PROCEDURE PRINT used:
      real time          0.01 seconds
      cpu time           0.01 seconds
```

Number of wire worms found for 2 fumigants and a control  
 Fumigants are C and S, control is 0, 5 BLOCKS  
 ANOVA with PROC MIXED - RBD with reps  
 Output from the OUTP option

Obs	FUMIGANT	BLOCK	REP	WORMS	LWORMS	Pred	Pred	DF	Alpha	Lower	Upper	Resid
1	C	I	1	5	1.79176	4.4423	1.29594	49.6771	0.05	1.8389	7.0457	0.55770
2	C	I	2	4	1.60944	4.4423	1.29594	49.6771	0.05	1.8389	7.0457	-0.44230
3	C	I	3	5	1.79176	4.4423	1.29594	49.6771	0.05	1.8389	7.0457	0.55770
4	C	I	4	2	1.09861	4.4423	1.29594	49.6771	0.05	1.8389	7.0457	-2.44230
5	C	II	1	0	0.00000	4.0354	1.29594	49.6771	0.05	1.4320	6.6388	-4.03542
6	C	II	2	9	2.30259	4.0354	1.29594	49.6771	0.05	1.4320	6.6388	4.96458
7	C	II	3	3	1.38629	4.0354	1.29594	49.6771	0.05	1.4320	6.6388	-1.03542
8	C	II	4	3	1.38629	4.0354	1.29594	49.6771	0.05	1.4320	6.6388	-1.03542
9	C	III	1	4	1.60944	5.0385	1.29594	49.6771	0.05	2.4351	7.6419	-1.03852
10	C	III	2	4	1.60944	5.0385	1.29594	49.6771	0.05	2.4351	7.6419	-1.03852
11	C	III	3	3	1.38629	5.0385	1.29594	49.6771	0.05	2.4351	7.6419	-2.03852
12	C	III	4	9	2.30259	5.0385	1.29594	49.6771	0.05	2.4351	7.6419	3.96148
13	C	IV	1	7	2.07944	6.5623	1.29594	49.6771	0.05	3.9589	9.1657	0.43771
14	C	IV	2	3	1.38629	6.5623	1.29594	49.6771	0.05	3.9589	9.1657	-3.56229
15	C	IV	3	5	1.79176	6.5623	1.29594	49.6771	0.05	3.9589	9.1657	-1.56229
16	C	IV	4	12	2.56495	6.5623	1.29594	49.6771	0.05	3.9589	9.1657	5.43771
17	C	V	1	4	1.60944	6.1715	1.29594	49.6771	0.05	3.5681	8.7748	-2.17147
18	C	V	2	9	2.30259	6.1715	1.29594	49.6771	0.05	3.5681	8.7748	2.82853
19	C	V	3	8	2.19722	6.1715	1.29594	49.6771	0.05	3.5681	8.7748	1.82853
20	C	V	4	6	1.94591	6.1715	1.29594	49.6771	0.05	3.5681	8.7748	-0.17147
21	S	I	1	5	1.79176	3.8037	1.29594	49.6771	0.05	1.2003	6.4071	1.19633
22	S	I	2	5	1.79176	3.8037	1.29594	49.6771	0.05	1.2003	6.4071	1.19633
23	S	I	3	1	0.69315	3.8037	1.29594	49.6771	0.05	1.2003	6.4071	-2.80367
24	S	I	4	2	1.09861	3.8037	1.29594	49.6771	0.05	1.2003	6.4071	-1.80367
25	S	II	1	6	1.94591	4.4972	1.29594	49.6771	0.05	1.8938	7.1005	1.50284
26	S	II	2	4	1.60944	4.4972	1.29594	49.6771	0.05	1.8938	7.1005	-0.49716
27	S	II	3	5	1.79176	4.4972	1.29594	49.6771	0.05	1.8938	7.1005	0.50284

28	S	II	4	4	1.60944	4.4972	1.29594	49.6771	0.05	1.8938	7.1005	-0.49716
29	S	III	1	2	1.09861	5.0287	1.29594	49.6771	0.05	2.4253	7.6321	-3.02867
30	S	III	2	9	2.30259	5.0287	1.29594	49.6771	0.05	2.4253	7.6321	3.97133
31	S	III	3	3	1.38629	5.0287	1.29594	49.6771	0.05	2.4253	7.6321	-2.02867
32	S	III	4	7	2.07944	5.0287	1.29594	49.6771	0.05	2.4253	7.6321	1.97133
33	S	IV	1	6	1.94591	5.6093	1.29594	49.6771	0.05	3.0059	8.2126	0.39074
34	S	IV	2	4	1.60944	5.6093	1.29594	49.6771	0.05	3.0059	8.2126	-1.60926
35	S	IV	3	8	2.19722	5.6093	1.29594	49.6771	0.05	3.0059	8.2126	2.39074
36	S	IV	4	4	1.60944	5.6093	1.29594	49.6771	0.05	3.0059	8.2126	-1.60926
37	S	V	1	2	1.09861	5.0612	1.29594	49.6771	0.05	2.4579	7.6646	-3.06124
38	S	V	2	9	2.30259	5.0612	1.29594	49.6771	0.05	2.4579	7.6646	3.93876
39	S	V	3	7	2.07944	5.0612	1.29594	49.6771	0.05	2.4579	7.6646	3.93876
40	S	V	4	3	1.38629	5.0612	1.29594	49.6771	0.05	2.4579	7.6646	-2.06124
41	O	I	1	12	2.56495	11.1245	1.29594	49.6771	0.05	8.5211	13.7279	0.87550
42	O	I	2	20	3.04452	11.1245	1.29594	49.6771	0.05	8.5211	13.7279	8.87550
43	O	I	3	8	2.19722	11.1245	1.29594	49.6771	0.05	8.5211	13.7279	-3.12450
44	O	I	4	8	2.19722	11.1245	1.29594	49.6771	0.05	8.5211	13.7279	-3.12450
45	O	II	1	7	2.07944	6.4733	1.29594	49.6771	0.05	3.8699	9.0767	0.52670
46	O	II	2	4	1.60944	6.4733	1.29594	49.6771	0.05	3.8699	9.0767	-2.47330
47	O	II	3	4	1.60944	6.4733	1.29594	49.6771	0.05	3.8699	9.0767	-2.47330
48	O	II	4	5	1.79176	6.4733	1.29594	49.6771	0.05	3.8699	9.0767	-1.47330
49	O	III	1	9	2.30259	8.7340	1.29594	49.6771	0.05	6.1306	11.3374	0.26602
50	O	III	2	6	1.94591	8.7340	1.29594	49.6771	0.05	6.1306	11.3374	-2.73398
51	O	III	3	7	2.07944	8.7340	1.29594	49.6771	0.05	6.1306	11.3374	-1.73398
52	O	III	4	11	2.48491	8.7340	1.29594	49.6771	0.05	6.1306	11.3374	2.26602
53	O	IV	1	12	2.56495	14.0305	1.29594	49.6771	0.05	11.4271	16.6338	-2.03046
54	O	IV	2	22	3.13549	14.0305	1.29594	49.6771	0.05	11.4271	16.6338	7.96954
55	O	IV	3	17	2.89037	14.0305	1.29594	49.6771	0.05	11.4271	16.6338	2.96954
56	O	IV	4	13	2.63906	14.0305	1.29594	49.6771	0.05	11.4271	16.6338	-1.03046
57	O	V	1	7	2.07944	8.1378	1.29594	49.6771	0.05	5.5344	10.7411	-1.13776
58	O	V	2	8	2.19722	8.1378	1.29594	49.6771	0.05	5.5344	10.7411	-0.13776
59	O	V	3	5	1.79176	8.1378	1.29594	49.6771	0.05	5.5344	10.7411	-3.13776
60	O	V	4	9	2.30259	8.1378	1.29594	49.6771	0.05	5.5344	10.7411	0.86224

243           proc print data=residdataPM; TITLE4 'Output from the OUTPM  
option'; run;

NOTE: There were 60 observations read from the data set WORK.RESIDDATA PM.

NOTE: The PROCEDURE PRINT printed page 31.

NOTE: PROCEDURE PRINT used:

real time                   0.02 seconds  
cpu time                    0.02 seconds

Number of wire worms found for 2 fumigants and a control

Fumigants are C and S, control is 0, 5 BLOCKS

ANOVA with PROC MIXED - RBD with reps

Output from the OUTPM option

Obs	FUMIGANT	BLOCK	REP	WORMS	LWORMS	Pred	Pred	DF	Alpha	Lower	Upper	Resid
1	C	I	1	5	1.79176	5.25	1.20312	11.4653	0.05	2.61500	7.8850	-0.25
2	C	I	2	4	1.60944	5.25	1.20312	11.4653	0.05	2.61500	7.8850	-1.25
3	C	I	3	5	1.79176	5.25	1.20312	11.4653	0.05	2.61500	7.8850	-0.25
4	C	I	4	2	1.09861	5.25	1.20312	11.4653	0.05	2.61500	7.8850	-3.25
5	C	II	1	0	0.00000	5.25	1.20312	11.4653	0.05	2.61500	7.8850	-5.25
6	C	II	2	9	2.30259	5.25	1.20312	11.4653	0.05	2.61500	7.8850	3.75
7	C	II	3	3	1.38629	5.25	1.20312	11.4653	0.05	2.61500	7.8850	-2.25
8	C	II	4	3	1.38629	5.25	1.20312	11.4653	0.05	2.61500	7.8850	-2.25
9	C	III	1	4	1.60944	5.25	1.20312	11.4653	0.05	2.61500	7.8850	-1.25
10	C	III	2	4	1.60944	5.25	1.20312	11.4653	0.05	2.61500	7.8850	-1.25
11	C	III	3	3	1.38629	5.25	1.20312	11.4653	0.05	2.61500	7.8850	-2.25
12	C	III	4	9	2.30259	5.25	1.20312	11.4653	0.05	2.61500	7.8850	3.75
13	C	IV	1	7	2.07944	5.25	1.20312	11.4653	0.05	2.61500	7.8850	1.75
14	C	IV	2	3	1.38629	5.25	1.20312	11.4653	0.05	2.61500	7.8850	-2.25
15	C	IV	3	5	1.79176	5.25	1.20312	11.4653	0.05	2.61500	7.8850	-0.25
16	C	IV	4	12	2.56495	5.25	1.20312	11.4653	0.05	2.61500	7.8850	6.75
17	C	V	1	4	1.60944	5.25	1.20312	11.4653	0.05	2.61500	7.8850	-1.25
18	C	V	2	9	2.30259	5.25	1.20312	11.4653	0.05	2.61500	7.8850	3.75
19	C	V	3	8	2.19722	5.25	1.20312	11.4653	0.05	2.61500	7.8850	2.75
20	C	V	4	6	1.94591	5.25	1.20312	11.4653	0.05	2.61500	7.8850	0.75
21	S	I	1	5	1.79176	4.80	1.20312	11.4653	0.05	2.16500	7.4350	0.20
22	S	I	2	5	1.79176	4.80	1.20312	11.4653	0.05	2.16500	7.4350	0.20
23	S	I	3	1	0.69315	4.80	1.20312	11.4653	0.05	2.16500	7.4350	-3.80
24	S	I	4	2	1.09861	4.80	1.20312	11.4653	0.05	2.16500	7.4350	-2.80
25	S	II	1	6	1.94591	4.80	1.20312	11.4653	0.05	2.16500	7.4350	1.20
26	S	II	2	4	1.60944	4.80	1.20312	11.4653	0.05	2.16500	7.4350	-0.80
27	S	II	3	5	1.79176	4.80	1.20312	11.4653	0.05	2.16500	7.4350	0.20
28	S	II	4	4	1.60944	4.80	1.20312	11.4653	0.05	2.16500	7.4350	-0.80
29	S	III	1	2	1.09861	4.80	1.20312	11.4653	0.05	2.16500	7.4350	-2.80
30	S	III	2	9	2.30259	4.80	1.20312	11.4653	0.05	2.16500	7.4350	4.20
31	S	III	3	3	1.38629	4.80	1.20312	11.4653	0.05	2.16500	7.4350	-1.80
32	S	III	4	7	2.07944	4.80	1.20312	11.4653	0.05	2.16500	7.4350	2.20
33	S	IV	1	6	1.94591	4.80	1.20312	11.4653	0.05	2.16500	7.4350	1.20
34	S	IV	2	4	1.60944	4.80	1.20312	11.4653	0.05	2.16500	7.4350	-0.80
35	S	IV	3	8	2.19722	4.80	1.20312	11.4653	0.05	2.16500	7.4350	3.20

36	S	IV	4	4	1.60944	4.80	1.20312	11.4653	0.05	2.16500	7.4350	-0.80
37	S	V	1	2	1.09861	4.80	1.20312	11.4653	0.05	2.16500	7.4350	-2.80
38	S	V	2	9	2.30259	4.80	1.20312	11.4653	0.05	2.16500	7.4350	4.20
39	S	V	3	7	2.07944	4.80	1.20312	11.4653	0.05	2.16500	7.4350	2.20
40	S	V	4	3	1.38629	4.80	1.20312	11.4653	0.05	2.16500	7.4350	-1.80
41	0	I	1	12	2.56495	9.70	1.20312	11.4653	0.05	7.06500	12.3350	2.30
42	0	I	2	20	3.04452	9.70	1.20312	11.4653	0.05	7.06500	12.3350	10.30
43	0	I	3	8	2.19722	9.70	1.20312	11.4653	0.05	7.06500	12.3350	-1.70
44	0	I	4	8	2.19722	9.70	1.20312	11.4653	0.05	7.06500	12.3350	-1.70
45	0	II	1	7	2.07944	9.70	1.20312	11.4653	0.05	7.06500	12.3350	-2.70
46	0	II	2	4	1.60944	9.70	1.20312	11.4653	0.05	7.06500	12.3350	-5.70
47	0	II	3	4	1.60944	9.70	1.20312	11.4653	0.05	7.06500	12.3350	-5.70
48	0	II	4	5	1.79176	9.70	1.20312	11.4653	0.05	7.06500	12.3350	-4.70
49	0	III	1	9	2.30259	9.70	1.20312	11.4653	0.05	7.06500	12.3350	-0.70
50	0	III	2	6	1.94591	9.70	1.20312	11.4653	0.05	7.06500	12.3350	-3.70
51	0	III	3	7	2.07944	9.70	1.20312	11.4653	0.05	7.06500	12.3350	-2.70
52	0	III	4	11	2.48491	9.70	1.20312	11.4653	0.05	7.06500	12.3350	1.30
53	0	IV	1	12	2.56495	9.70	1.20312	11.4653	0.05	7.06500	12.3350	2.30
54	0	IV	2	22	3.13549	9.70	1.20312	11.4653	0.05	7.06500	12.3350	12.30
55	0	IV	3	17	2.89037	9.70	1.20312	11.4653	0.05	7.06500	12.3350	7.30
56	0	IV	4	13	2.63906	9.70	1.20312	11.4653	0.05	7.06500	12.3350	3.30
57	0	V	1	7	2.07944	9.70	1.20312	11.4653	0.05	7.06500	12.3350	-2.70
58	0	V	2	8	2.19722	9.70	1.20312	11.4653	0.05	7.06500	12.3350	-1.70
59	0	V	3	5	1.79176	9.70	1.20312	11.4653	0.05	7.06500	12.3350	-4.70
60	0	V	4	9	2.30259	9.70	1.20312	11.4653	0.05	7.06500	12.3350	-0.70

```

244      proc univariate data=ResidDataP plot normal; var resid;
245          TITLE3 'Univariate analysis for PROC MIXED - RBD with reps';
246      run;

```

NOTE: The PROCEDURE UNIVARIATE printed page 32.

NOTE: PROCEDURE UNIVARIATE used:

```

      real time          0.02 seconds
      cpu time          0.02 seconds

```

Number of wire worms found for 2 fumigants and a control

Fumigants are C and S, control is 0, 5 BLOCKS

Univariate analysis for PROC MIXED - RBD with reps

The UNIVARIATE Procedure

Variable: Resid

		Moments	
N	60	Sum Weights	60
Mean	0	Sum Observations	0
Std Deviation	2.74808542	Variance	7.55197347
Skewness	1.14385572	Kurtosis	1.43592384
Uncorrected SS	445.566435	Corrected SS	445.566435
Coeff Variation	.	Std Error Mean	0.3547763

#### Basic Statistical Measures

Location		Variability	
Mean	0.00000	Std Deviation	2.74809
Median	-0.49716	Variance	7.55197
Mode	-3.12450	Range	12.91092
		Interquartile Range	3.38408

NOTE: The mode displayed is the smallest of 8 modes with a count of 2.

#### Tests for Location: Mu0=0

Test	-Statistic-	-----p Value-----	
Student's t	t	Pr >  t	1.0000
Sign	M	Pr >=  M	0.3663
Signed Rank	S	Pr >=  S	0.4227

#### Tests for Normality

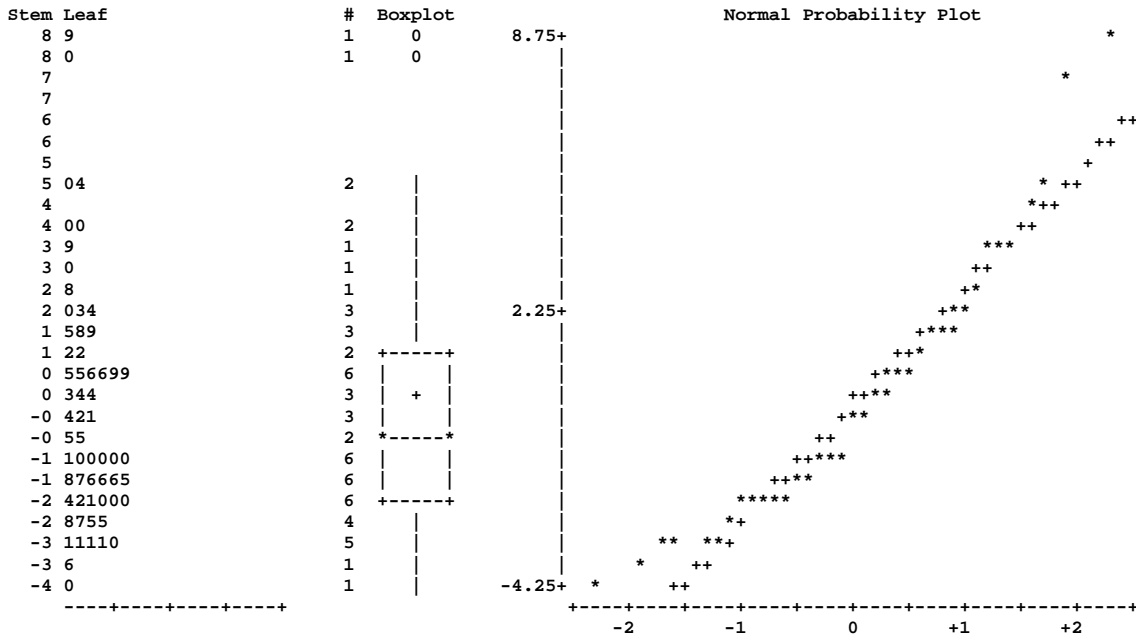
Test	--Statistic--	-----p Value-----	
Shapiro-Wilk	W	Pr < W	0.0007
Kolmogorov-Smirnov	D	Pr > D	0.0136
Cramer-von Mises	W-Sq	Pr > W-Sq	0.0080
Anderson-Darling	A-Sq	Pr > A-Sq	<0.0050

Quantiles (Definition 5)

Quantile	Estimate
100% Max	8.875503
99%	8.875503
95%	5.201148
90%	3.950118
75% Q3	1.349586
50% Median	-0.497159
25% Q1	-2.034492
10%	-3.044958
5%	-3.131129
1%	-4.035419
0% Min	-4.035419

Extreme Observations

-----Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
-4.03542	5	3.97133	30
-3.56229	14	4.96458	6
-3.13776	59	5.43771	16
-3.12450	44	7.96954	54
-3.12450	43	8.87550	42



```

247      proc sort data=FUMIGANT; by BLOCK FUMIGANT; run;
NOTE: There were 60 observations read from the data set WORK.FUMIGANT.
NOTE: The data set WORK.FUMIGANT has 60 observations and 5 variables.
NOTE: PROCEDURE SORT used:
      real time          0.04 seconds
      cpu time           0.04 seconds

247      !
248      proc means data=FUMIGANT noprint; by BLOCK FUMIGANT; var WORMS;
249      output out=next4 n=n mean=mean var=var; run;
NOTE: There were 60 observations read from the data set WORK.FUMIGANT.
NOTE: The data set WORK.NEXT4 has 15 observations and 7 variables.
NOTE: PROCEDURE MEANS used:
      real time          0.04 seconds
      cpu time           0.04 seconds
    
```



```
250      proc plot data=next4; plot var*mean; run;
```

NOTE: There were 15 observations read from the data set WORK.NEXT4.

NOTE: The PROCEDURE PLOT printed page 33.

NOTE: PROCEDURE PLOT used:

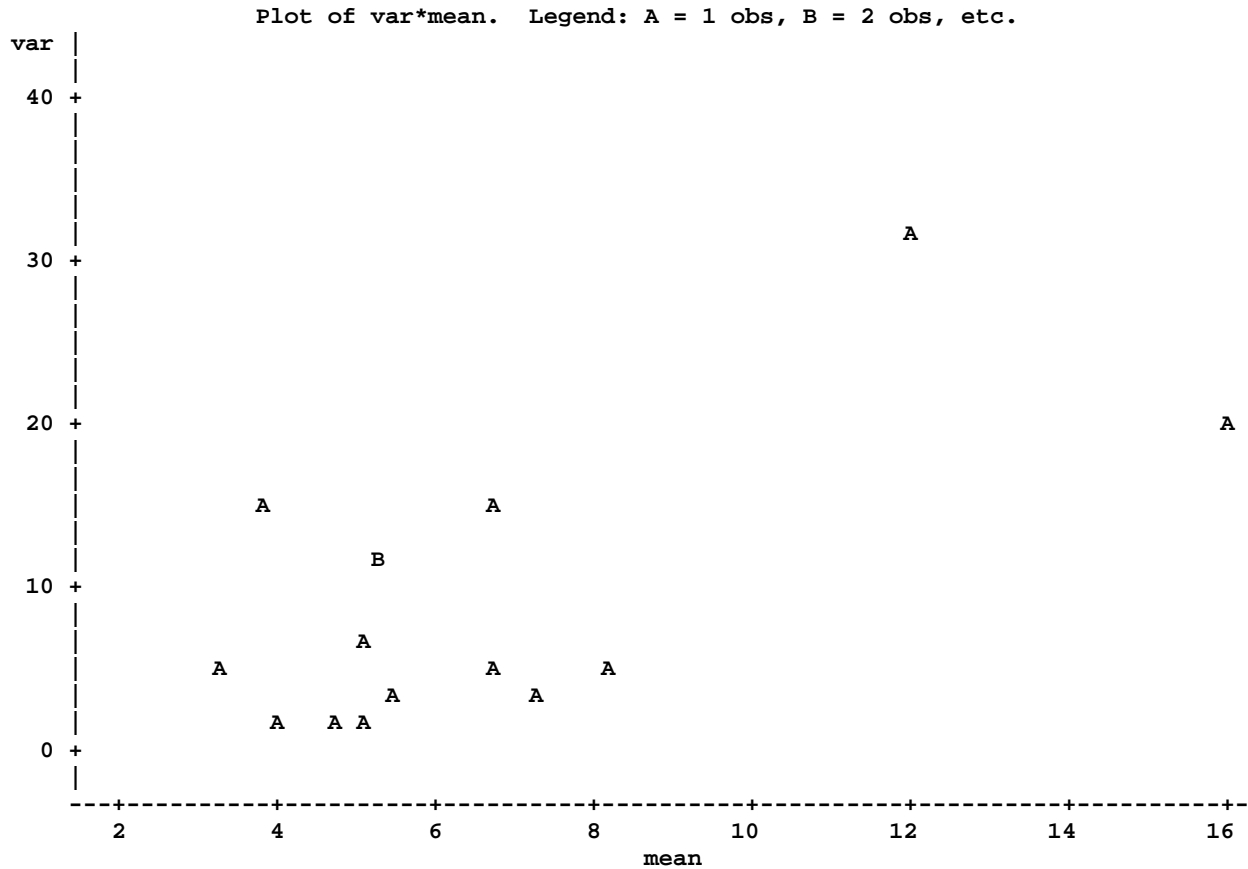
real time            0.01 seconds

cpu time             0.01 seconds

Number of wire worms found for 2 fumigants and a control

Fumigants are C and S, control is 0, 5 BLOCKS

Univariate analysis for PROC MIXED - RBD with reps



```
251      PROC CHART DATA=FUMIGANT; OPTIONS PS=45 LS=88;
```

```
252      TITLE3 'Histogram of means for PROC MIXED - RBD with reps';
```

```
253      VBAR FUMIGANT / SUMVAR=WORMS TYPE=MEAN; RUN;
```

NOTE: The PROCEDURE CHART printed page 34.

NOTE: PROCEDURE CHART used:

real time            0.00 seconds

cpu time             0.00 seconds

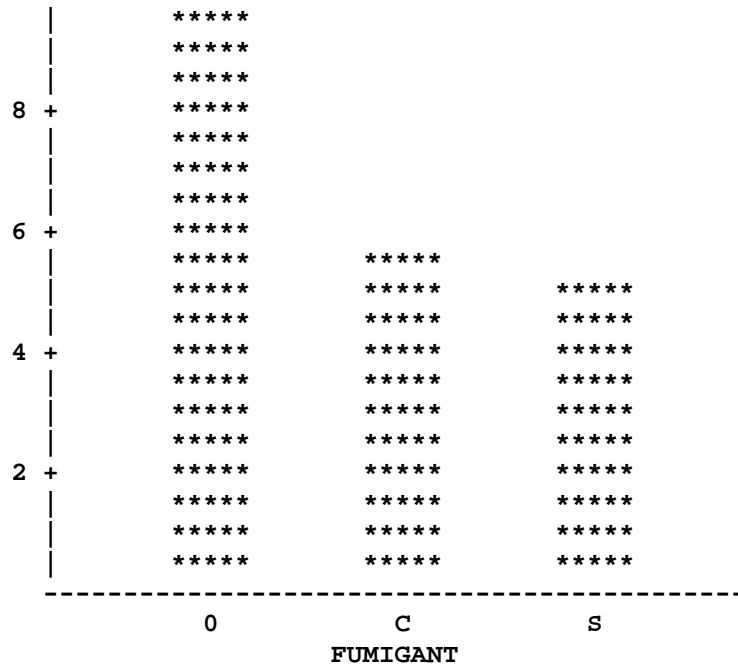
```
254      OPTIONS PS=256 LS=111;
```

Number of wire worms found for 2 fumigants and a control

Fumigants are C and S, control is 0, 5 BLOCKS

Histogram of means for PROC MIXED - RBD with reps

WORMS Mean



```

255     PROC mixed DATA=FUMIGANT cl COVTEST; CLASSES FUMIGANT BLOCK REP;
256         TITLE3 'ANOVA with PROC MIXED - RBD with reps - using Logarithms';
257     MODEL LWORMS = FUMIGANT / htype=3 DDFM=Satterthwaite outp=ResidDataP;
258     RANDOM BLOCK FUMIGANT*BLOCK;
259     lsmeans fumigant / pdiff ADJUST=DUNNETT diff=control('0');
260     lsmeans fumigant / pdiff ADJUST=tukey;
261     RUN;
NOTE: Convergence criteria met.
NOTE: The data set WORK.RESIDDATAP has 60 observations and 12 variables.
NOTE: The PROCEDURE MIXED printed page 35.
NOTE: PROCEDURE MIXED used:
      real time           0.18 seconds
      cpu time            0.18 seconds
261     !           QUIT;

```

Number of wire worms found for 2 fumigants and a control

Fumigants are C and S, control is 0, 5 BLOCKS

ANOVA with PROC MIXED - RBD with reps - using Logarithms

The Mixed Procedure

Model Information	
Data Set	WORK.FUMIGANT
Dependent Variable	LWORMS
Covariance Structure	Variance Components
Estimation Method	REML
Residual Variance Method	Profile
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Satterthwaite

## Class Level Information

Class	Levels	Values
FUMIGANT	3	0 C S
BLOCK	5	I II III IV V
REP	4	1 2 3 4

## Dimensions

Covariance Parameters	3
Columns in X	4
Columns in Z	20
Subjects	1
Max Obs Per Subject	60
Observations Used	60
Observations Not Used	0
Total Observations	60

## Iteration History

Iteration	Evaluations	-2 Res Log Like	Criterion
0	1	88.06288591	
1	1	84.95995798	0.00000000

Convergence criteria met.

## Covariance Parameter Estimates

Cov Parm	Estimate	Standard Error	Z Value	Pr > Z	Alpha	Lower	Upper
BLOCK	0.02554	0.03624	0.70	0.2405	0.05	0.005068	27.2141
FUMIGANT*BLOCK	0.02017	0.03609	0.56	0.2881	0.05	0.003244	1200.67
Residual	0.1959	0.04131	4.74	<.0001	0.05	0.1348	0.3108

## Fit Statistics

-2 Res Log Likelihood	85.0
AIC (smaller is better)	91.0
AICC (smaller is better)	91.4
BIC (smaller is better)	89.8

## Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
FUMIGANT	2	8	8.30	0.0112

## Least Squares Means

Effect	FUMIGANT	Estimate	Standard Error	DF	t Value	Pr >  t
FUMIGANT	0	2.2754	0.1376	10.5	16.53	<.0001
FUMIGANT	C	1.7076	0.1376	10.5	12.41	<.0001
FUMIGANT	S	1.6714	0.1376	10.5	12.14	<.0001
FUMIGANT	0	2.2754	0.1376	10.5	16.53	<.0001
FUMIGANT	C	1.7076	0.1376	10.5	12.41	<.0001
FUMIGANT	S	1.6714	0.1376	10.5	12.14	<.0001

## Differences of Least Squares Means

Effect	FUMIGANT	_FUMIGANT	Estimate	Standard Error	DF	t Value	Tails	Pr > t	Adjustment	Adj P
FUMIGANT	0	C	0.5678	0.1663	8	3.41	Upper	0.0046	Dunnett-Hsu	0.0083
FUMIGANT	0	S	0.6040	0.1663	8	3.63	Upper	0.0033	Dunnett-Hsu	0.0061
FUMIGANT	0	C	0.5678	0.1663	8	3.41	Both	0.0092	Tukey-Kramer	0.0223
FUMIGANT	0	S	0.6040	0.1663	8	3.63	Both	0.0067	Tukey-Kramer	0.0163
FUMIGANT	C	S	0.03622	0.1663	8	0.22	Both	0.8331	Tukey-Kramer	0.9743

```

262      proc univariate data=ResidDataP plot normal; var resid;
263          TITLE3 'Univariate analysis for PROC MIXED on Logs - RBD with reps';
264      run;

```

NOTE: The PROCEDURE UNIVARIATE printed page 36.

NOTE: PROCEDURE UNIVARIATE used:

```

      real time          0.02 seconds
      cpu time           0.02 seconds

```

```

265      proc sort data=FUMIGANT; by BLOCK FUMIGANT; run;

```

NOTE: Input data set is already sorted, no sorting done.

NOTE: PROCEDURE SORT used:

```

      real time          0.00 seconds
      cpu time           0.00 seconds

```

```

265      !                                     OPTIONS PS=45 LS=88;

```

Number of wire worms found for 2 fumigants and a control  
 Fumigants are C and S, control is 0, 5 BLOCKS  
 Univariate analysis for PROC MIXED on Logs - RBD with reps  
 The UNIVARIATE Procedure  
 Variable: Resid

Moments			
N	60	Sum Weights	60
Mean	0	Sum Observations	0
Std Deviation	0.41560217	Variance	0.17272516
Skewness	-0.5865127	Kurtosis	1.54273956
Uncorrected SS	10.1907847	Corrected SS	10.1907847
Coeff Variation	.	Std Error Mean	0.05365401

Basic Statistical Measures			
Location		Variability	
Mean	0.00000	Std Deviation	0.41560
Median	0.02165	Variance	0.17273
Mode	-0.41081	Range	2.30259
		Interquartile Range	0.47828

NOTE: The mode displayed is the smallest of 8 modes with a count of 2.

Tests for Location: Mu0=0				
Test	-Statistic-		-----p Value-----	
Student's t	t	0	Pr >  t	1.0000
Sign	M	1	Pr >=  M	0.8974
Signed Rank	S	31	Pr >=  S	0.8217

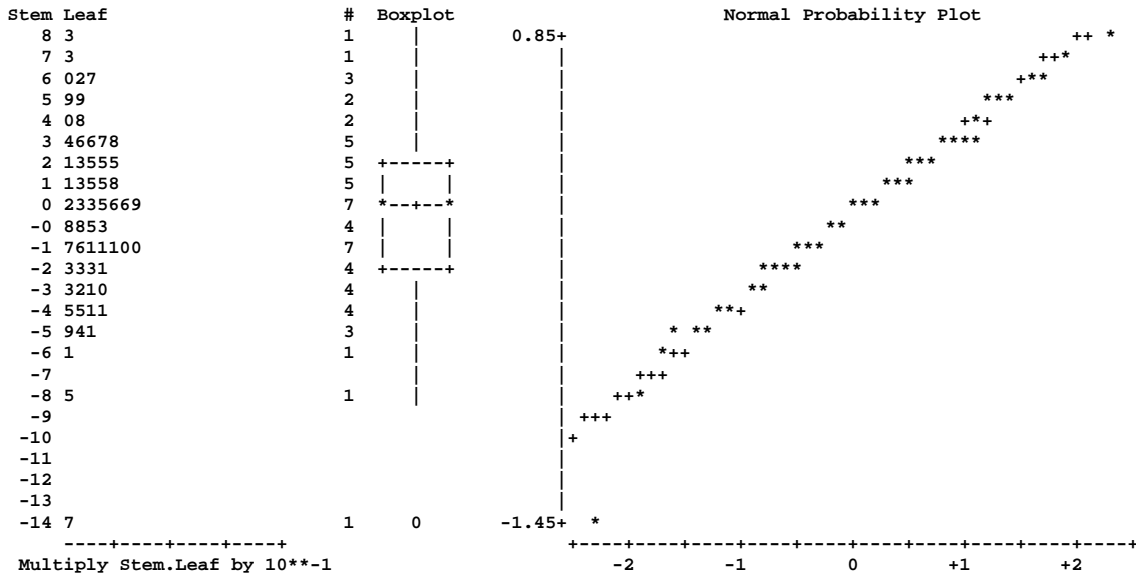
Tests for Normality				
Test	--Statistic--		-----p Value-----	
Shapiro-Wilk	W	0.971472	Pr < W	0.1722
Kolmogorov-Smirnov	D	0.058041	Pr > D	>0.1500
Cramer-von Mises	W-Sq	0.025185	Pr > W-Sq	>0.2500
Anderson-Darling	A-Sq	0.239627	Pr > A-Sq	>0.2500

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.831431
99%	0.831431
95%	0.643056
90%	0.588689
75% Q3	0.249212
50% Median	0.021650
25% Q1	-0.229068
10%	-0.481377
5%	-0.596016
1%	-1.471154
0% Min	-1.471154

Extreme Observations

-----Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
-1.471154	17	0.597013	58
-0.853315	11	0.618902	34
-0.606960	57	0.667211	44
-0.585071	33	0.732700	2
-0.540326	8	0.831431	18



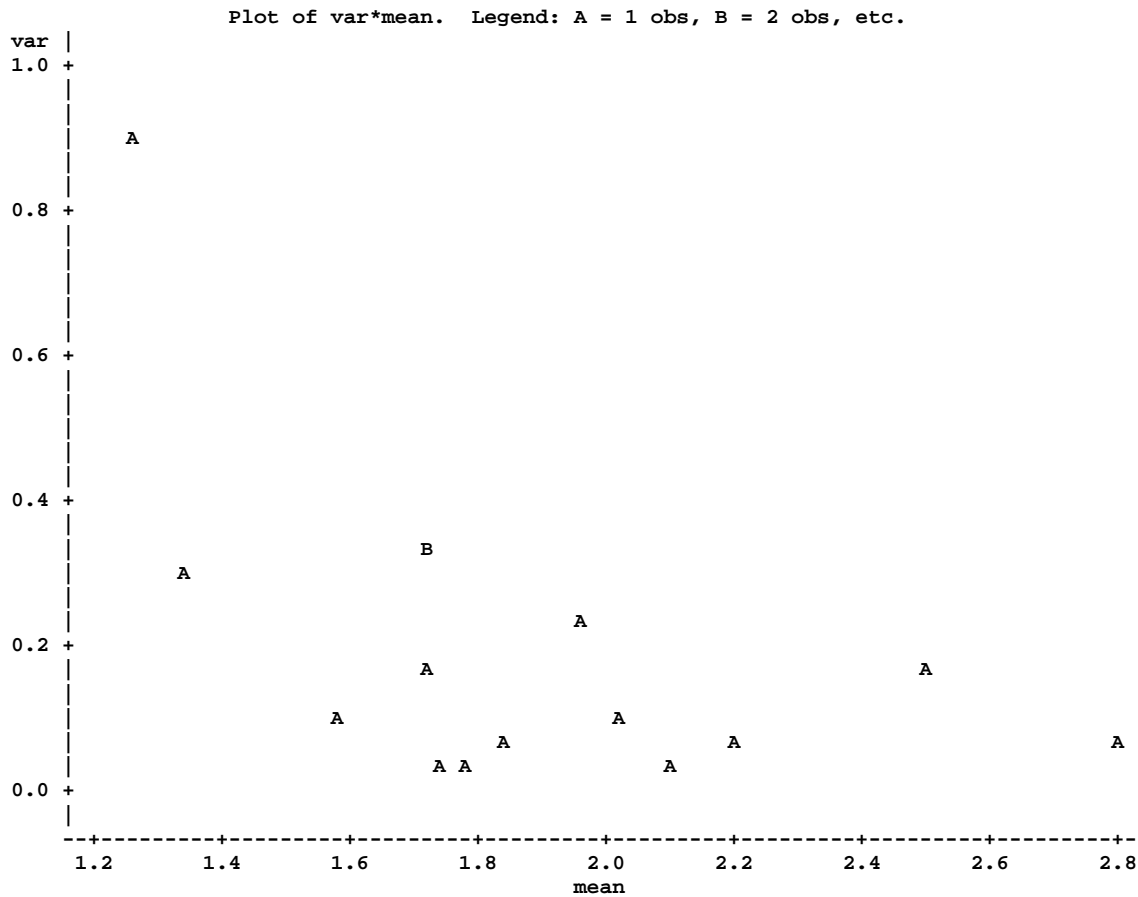
```

266      proc means data=FUMIGANT noprint; by BLOCK FUMIGANT; var LWORMS;
267      output out=next5 n=n mean=mean var=var; run;
NOTE: There were 60 observations read from the data set WORK.FUMIGANT.
NOTE: The data set WORK.NEXT5 has 15 observations and 7 variables.
NOTE: PROCEDURE MEANS used:
      real time          0.03 seconds
      cpu time           0.03 seconds
268      proc plot data=next5; plot var*mean;
269      TITLE3 'Variance/Mean plot for PROC MIXED on Logarithms - RBD
with reps';
270      run;
271
272      OPTIONS PS=256 LS=111;
NOTE: There were 15 observations read from the data set WORK.NEXT5.
NOTE: The PROCEDURE PLOT printed page 37.
NOTE: PROCEDURE PLOT used:
      real time          0.02 seconds
      cpu time           0.02 seconds
    
```

Number of wire worms found for 2 fumigants and a control

Fumigants are C and S, control is 0, 5 BLOCKS

Variance/Mean plot for PROC MIXED on Logarithms - RBD with reps



```

273     PROC GLM DATA=FUMIGANT; CLASSES FUMIGANT BLOCK REP;
274         TITLE3 'ANOVA with PROC GLM - RBD with reps';
275     MODEL WORMS = FUMIGANT BLOCK FUMIGANT*BLOCK;
276     TEST H=FUMIGANT BLOCK E=FUMIGANT*BLOCK;
277     RANDOM FUMIGANT BLOCK FUMIGANT*BLOCK;
278     LSMEANS FUMIGANT BLOCK / pdiff stderr adjust=tukey;
279     RUN;

```

NOTE: TYPE I EMS not available without the E1 option.

```
279     !      QUIT;
```

NOTE: The PROCEDURE GLM printed pages 38-42.

NOTE: PROCEDURE GLM used:

real time            0.13 seconds

cpu time            0.12 seconds

Number of wire worms found for 2 fumigants and a control

Fumigants are C and S, control is 0, 5 BLOCKS

ANOVA with PROC GLM - RBD with reps

The GLM Procedure

Class Level Information

Class	Levels	Values
FUMIGANT	3	0 C S
BLOCK	5	I II III IV V
REP	4	1 2 3 4
Number of observations		60

Number of wire worms found for 2 fumigants and a control

Fumigants are C and S, control is 0, 5 BLOCKS

ANOVA with PROC GLM - RBD with reps

The GLM Procedure

Dependent Variable: WORMS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	14	640.833333	45.773810	5.03	<.0001
Error	45	409.750000	9.105556		
Corrected Total	59	1050.583333			

R-Square	Coeff Var	Root MSE	WORMS Mean
0.609979	45.83607	3.017541	6.583333

Source	DF	Type I SS	Mean Square	F Value	Pr > F
FUMIGANT	2	293.4333333	146.7166667	16.11	<.0001
BLOCK	4	151.1666667	37.7916667	4.15	0.0060
FUMIGANT*BLOCK	8	196.2333333	24.5291667	2.69	0.0164

Source	DF	Type III SS	Mean Square	F Value	Pr > F
FUMIGANT	2	293.4333333	146.7166667	16.11	<.0001
BLOCK	4	151.1666667	37.7916667	4.15	0.0060
FUMIGANT*BLOCK	8	196.2333333	24.5291667	2.69	0.0164

Tests of Hypotheses Using the Type III MS for FUMIGANT\*BLOCK as an Error Term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
FUMIGANT	2	293.4333333	146.7166667	5.98	0.0258
BLOCK	4	151.1666667	37.7916667	1.54	0.2790

Source	Type III Expected Mean Square
FUMIGANT	Var(Error) + 4 Var(FUMIGANT*BLOCK) + 20 Var(FUMIGANT)
BLOCK	Var(Error) + 4 Var(FUMIGANT*BLOCK) + 12 Var(BLOCK)
FUMIGANT*BLOCK	Var(Error) + 4 Var(FUMIGANT*BLOCK)

Least Squares Means

Adjustment for Multiple Comparisons: Tukey

FUMIGANT	WORMS LSMEAN	Standard Error	Pr >  t	LSMEAN Number
0	9.70000000	0.67474275	<.0001	1
C	5.25000000	0.67474275	<.0001	2
S	4.80000000	0.67474275	<.0001	3

Least Squares Means for effect FUMIGANT

Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: WORMS

i/j	1	2	3
1		<.0001	<.0001
2	<.0001		0.8850
3	<.0001	0.8850	

Number of wire worms found for 2 fumigants and a control

Fumigants are C and S, control is 0, 5 BLOCKS

ANOVA with PROC GLM - RBD with reps

The GLM Procedure

Least Squares Means

Adjustment for Multiple Comparisons: Tukey

BLOCK	WORMS LSMEAN	Standard Error	Pr >  t	LSMEAN Number
I	6.41666667	0.87108914	<.0001	1
II	4.50000000	0.87108914	<.0001	2
III	6.16666667	0.87108914	<.0001	3
IV	9.41666667	0.87108914	<.0001	4
V	6.41666667	0.87108914	<.0001	5

Least Squares Means for effect BLOCK

Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: WORMS

i/j	1	2	3	4	5
1		0.5327	0.9996	0.1246	1.0000
2	0.5327		0.6602	0.0021	0.5327
3	0.9996	0.6602		0.0803	0.9996
4	0.1246	0.0021	0.0803		0.1246
5	1.0000	0.5327	0.9996	0.1246	



```

282      **EXAMPLE 6*****;
283      *** Example of Latin Square Design          ***;
284      *** From Snedecor & Cochran, 1980 (pg 271) ***;
285      *****;
286      OPTIONS PS=256 LS=111 NOCENTER NODATE NONUMBER;
287      DATA MILLET; INFILE CARDS MISSEVER;
288          INPUT ROW COLUMN treatment $ YIELD;
289          TITLE1 'LATIN SQUARE WITH 5 ROWS, COLUMNS AND TREATMENTS';
290          TITLE2 'MILLET YIELDS (G) FOR SPACINGS OF 2, 4, 6, 8 AND 10 INCHES';
291          CARDS;
    
```

NOTE: The data set WORK.MILLET has 25 observations and 4 variables.

NOTE: DATA statement used:  
 real time 0.03 seconds  
 cpu time 0.03 seconds

```

291      !          RUN;
317      ;
318      PROC SORT; BY ROW COLUMN;
    
```

NOTE: There were 25 observations read from the data set WORK.MILLET.

NOTE: The data set WORK.MILLET has 25 observations and 4 variables.

NOTE: PROCEDURE SORT used:  
 real time 0.04 seconds  
 cpu time 0.04 seconds

```

319      PROC PRINT; VAR ROW COLUMN treatment YIELD; RUN;
    
```

NOTE: There were 25 observations read from the data set WORK.MILLET.

NOTE: The PROCEDURE PRINT printed page 43.

NOTE: PROCEDURE PRINT used:  
 real time 0.02 seconds  
 cpu time 0.02 seconds

LATIN SQUARE WITH 5 ROWS, COLUMNS AND TREATMENTS  
 MILLET YIELDS (G) FOR SPACINGS OF 2, 4, 6, 8 AND 10 INCHES

Obs	ROW	COLUMN	treatment	YIELD	13	3	3	C	280
1	1	1	B	257	14	3	4	D	246
2	1	2	E	230	15	3	5	A	250
3	1	3	A	279	16	4	1	A	203
4	1	4	C	287	17	4	2	C	204
5	1	5	D	202	18	4	3	D	227
6	2	1	D	245	19	4	4	E	193
7	2	2	A	283	20	4	5	B	259
8	2	3	E	245	21	5	1	C	231
9	2	4	B	280	22	5	2	D	271
10	2	5	C	260	23	5	3	B	266
11	3	1	E	182	24	5	4	A	334
12	3	2	B	252	25	5	5	E	338

```

320      PROC MIXED DATA=MILLET cl COVTEST; CLASSES ROW COLUMN treatment;
321          TITLE3 'ANOVA with PROC MIXED - Latin Square';
322          TITLE4 'Post-ANOVA tests will be done later with contrasts';
323          MODEL YIELD = treatment / htype=3 DDFM=Satterthwaite outp=ResidDataP;
324          RANDOM ROW COLUMN;
325      RUN;
    
```

NOTE: Convergence criteria met.

NOTE: The data set WORK.RESIDDATA P has 25 observations and 11 variables.

NOTE: The PROCEDURE MIXED printed page 44.

NOTE: PROCEDURE MIXED used:  
 real time 0.15 seconds  
 cpu time 0.15 seconds

```

325      !          QUIT;
    
```

LATIN SQUARE WITH 5 ROWS, COLUMNS AND TREATMENTS  
 MILLET YIELDS (G) FOR SPACINGS OF 2, 4, 6, 8 AND 10 INCHES  
 ANOVA with PROC MIXED - Latin Square  
 Post-ANOVA tests will be done later with contrasts  
 The Mixed Procedure

## Model Information

Data Set	WORK.MILLET
Dependent Variable	YIELD
Covariance Structure	Variance Components
Estimation Method	REML
Residual Variance Method	Profile
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Satterthwaite

## Class Level Information

Class	Levels	Values
ROW	5	1 2 3 4 5
COLUMN	5	1 2 3 4 5
treatment	5	A B C D E

## Dimensions

Covariance Parameters	3
Columns in X	6
Columns in Z	10
Subjects	1
Max Obs Per Subject	25
Observations Used	25
Observations Not Used	0
Total Observations	25

## Iteration History

Iteration	Evaluations	-2 Res Log Like	Criterion
0	1	212.61749317	
1	1	210.22285841	0.00000000

Convergence criteria met.

## Covariance Parameter Estimates

Cov Parm	Estimate	Standard		Pr > Z	Alpha	Lower	Upper
		Error	Z				
ROW	468.95	488.54	0.96	0.1686	0.05	122.70	24267
COLUMN	96.1867	233.77	0.41	0.3404	0.05	11.8899	7.401E10
Residual	1055.61	430.95	2.45	0.0072	0.05	542.81	2876.45

## Fit Statistics

-2 Res Log Likelihood	210.2
AIC (smaller is better)	216.2
AICC (smaller is better)	217.7
BIC (smaller is better)	215.1

## Type 3 Tests of Fixed Effects

Effect	Num		F Value	Pr > F
	DF	Den		
treatment	4	12	0.98	0.4523

326       proc univariate data=ResidDataP plot normal; var resid; run;

NOTE: The PROCEDURE UNIVARIATE printed page 45.

NOTE: PROCEDURE UNIVARIATE used:

real time	0.02 seconds
cpu time	0.02 seconds

LATIN SQUARE WITH 5 ROWS, COLUMNS AND TREATMENTS  
 MILLET YIELDS (G) FOR SPACINGS OF 2, 4, 6, 8 AND 10 INCHES  
 ANOVA with PROC MIXED - Latin Square  
 Post-ANOVA tests will be done later with contrasts

## The UNIVARIATE Procedure

Variable: Resid

		Moments	
N	25	Sum Weights	25
Mean	0	Sum Observations	0
Std Deviation	26.519579	Variance	703.288072
Skewness	0.5867556	Kurtosis	0.94966715
Uncorrected SS	16878.9137	Corrected SS	16878.9137
Coeff Variation	.	Std Error Mean	5.30391581

## Basic Statistical Measures

Location		Variability	
Mean	0.000000	Std Deviation	26.51958
Median	3.939099	Variance	703.28807
Mode	.	Range	112.32380
		Interquartile Range	32.83900

## Tests for Location: Mu0=0

Test	-Statistic-	-----p Value-----	
Student's t	t 0	Pr >  t	1.0000
Sign	M 0.5	Pr >=  M	1.0000
Signed Rank	S 0.5	Pr >=  S	0.9896

## Tests for Normality

Test	--Statistic--	-----p Value-----	
Shapiro-Wilk	W 0.942024	Pr < W	0.1648
Kolmogorov-Smirnov	D 0.14412	Pr > D	>0.1500
Cramer-von Mises	W-Sq 0.071451	Pr > W-Sq	>0.2500
Anderson-Darling	A-Sq 0.461065	Pr > A-Sq	0.2428

## Quantiles (Definition 5)

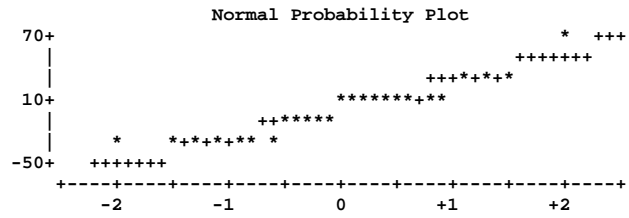
Quantile	Estimate
100% Max	72.66893
99%	72.66893
95%	34.52834
90%	32.33981
75% Q3	9.84803
50% Median	3.93910
25% Q1	-22.99096
10%	-37.17456
5%	-38.41741
1%	-39.65487
0% Min	-39.65487

## Extreme Observations

-----Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
-39.6549	11	17.2897	20
-38.4174	5	30.4420	4
-37.1746	21	32.3398	13
-33.7538	16	34.5283	24
-25.4509	19	72.6689	25

```

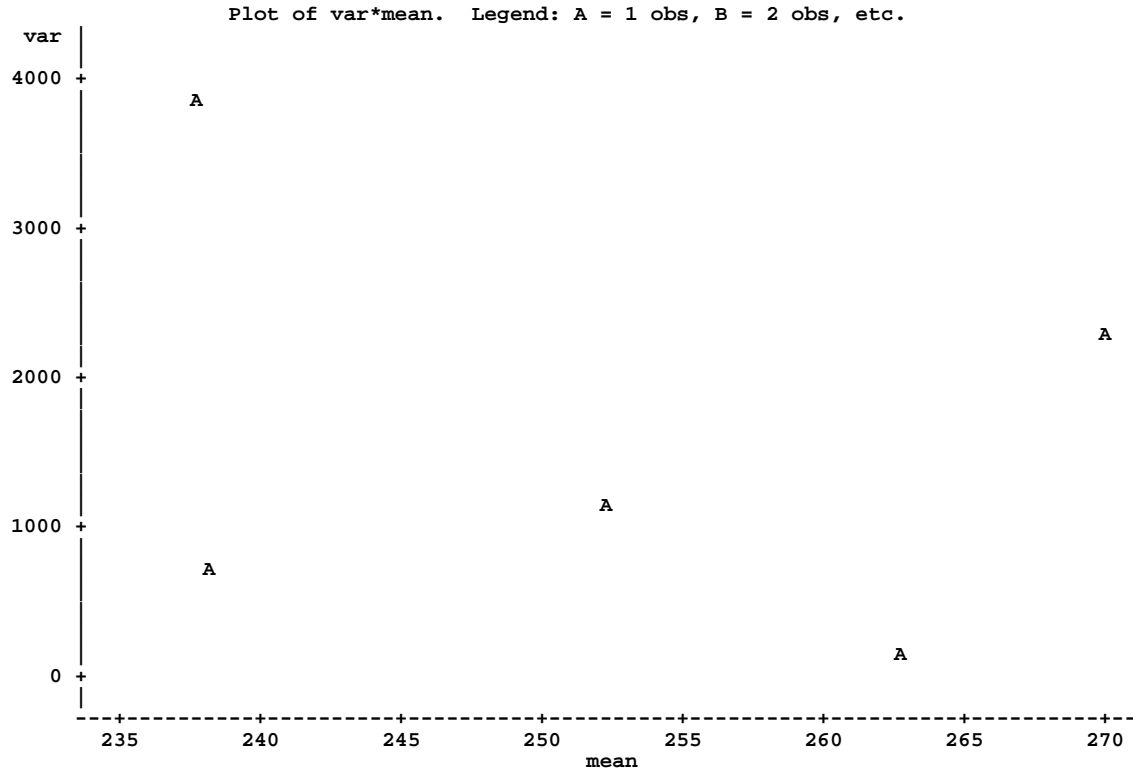
Stem Leaf      #  Boxplot
 6 3           1  0
 4
 2 025         3  |
 0 457899017   9  +-----+
-0 65322       5  |
-2 874543      6  +-----+
-4 0           1  |
-----+-----+
Multiply Stem.Leaf by 10**+1
  
```



```

327      proc sort data=MILLET; by treatment; run; OPTIONS PS=45 LS=88;
NOTE: There were 25 observations read from the data set WORK.MILLET.
NOTE: The data set WORK.MILLET has 25 observations and 4 variables.
NOTE: PROCEDURE SORT used:
      real time          0.04 seconds      cpu time          0.04 seconds
328      proc means data=MILLET noprint; by treatment; var YIELD;
329      output out=next6 n=n mean=mean var=var; run;
NOTE: There were 25 observations read from the data set WORK.MILLET.
NOTE: The data set WORK.NEXT6 has 5 observations and 6 variables.
NOTE: PROCEDURE MEANS used:
      real time          0.04 seconds      cpu time          0.04 seconds
330      proc plot data=next6; plot var*mean; run;
NOTE: There were 5 observations read from the data set WORK.NEXT6.
NOTE: The PROCEDURE PLOT printed page 46.
NOTE: PROCEDURE PLOT used:
      real time          0.01 seconds      cpu time          0.01 seconds
  
```

LATIN SQUARE WITH 5 ROWS, COLUMNS AND TREATMENTS  
 MILLET YIELDS (G) FOR SPACINGS OF 2, 4, 6, 8 AND 10 INCHES  
 ANOVA with PROC MIXED - Latin Square  
 Post-ANOVA tests will be done later with contrasts



```

331      PROC CHART DATA=MILLET; OPTIONS PS=45 LS=78;
332          TITLE3 'Histogram of mean number Millet yield by row spacing';
333          VBAR treatment / SUMVAR=YIELD TYPE=MEAN; RUN;

```

NOTE: The PROCEDURE CHART printed page 47.

NOTE: PROCEDURE CHART used:

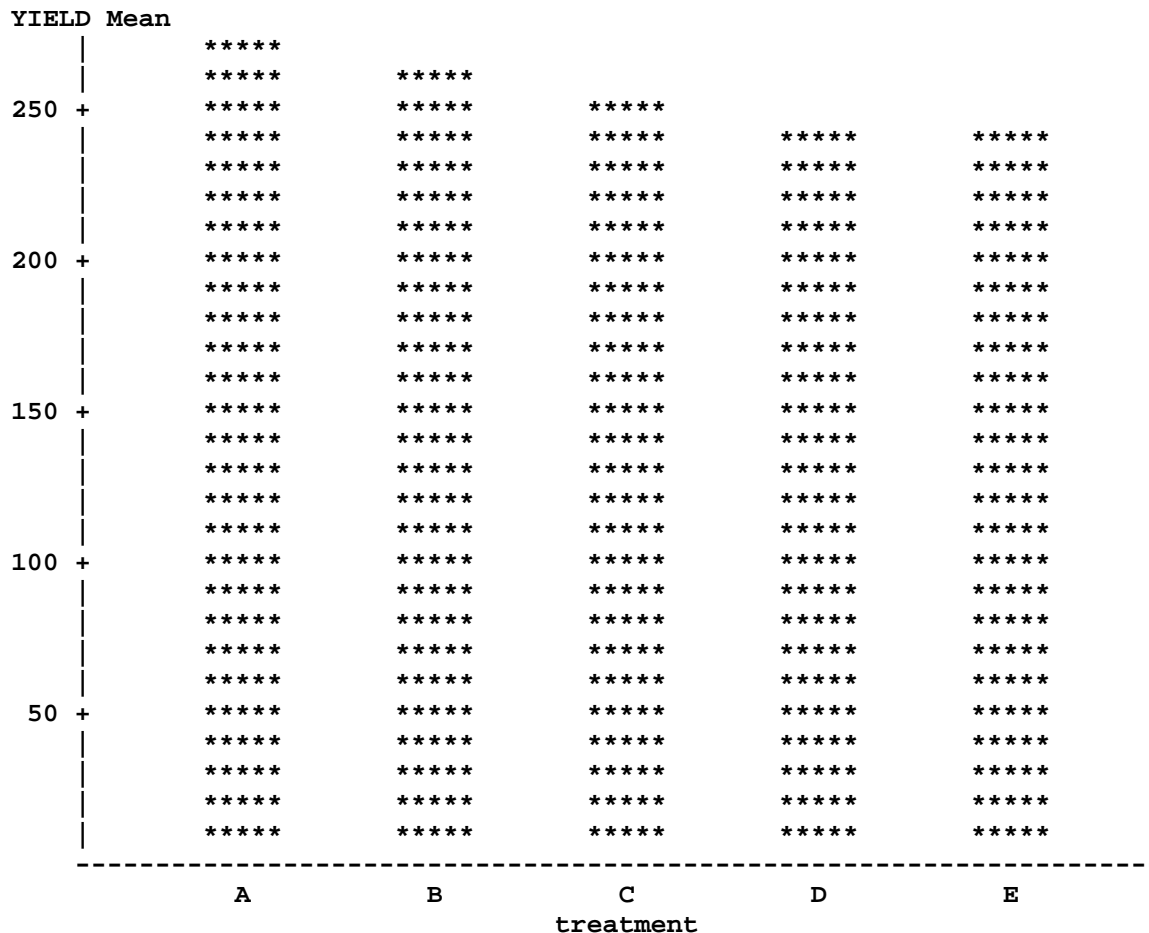
```

      real time          0.01 seconds
      cpu time           0.01 seconds

```

334

LATIN SQUARE WITH 5 ROWS, COLUMNS AND TREATMENTS  
MILLET YIELDS (G) FOR SPACINGS OF 2, 4, 6, 8 AND 10 INCHES  
Histogram of mean number Millet yield by row spacing



```

335      OPTIONS PS=256 LS=78;
336      PROC GLM DATA=MILLET; CLASSES ROW COLUMN treatment;
337          TITLE3 'ANOVA with PROC GLM - Latin Square';
338          MODEL YIELD = ROW COLUMN treatment;
339          RANDOM ROW COLUMN;
340      RUN;

```

NOTE: TYPE I EMS not available without the E1 option.

```
340      !      QUIT;
```

NOTE: The PROCEDURE GLM printed pages 48-50.

NOTE: PROCEDURE GLM used:

```

      real time          0.09 seconds
      cpu time           0.09 seconds

```

LATIN SQUARE WITH 5 ROWS, COLUMNS AND TREATMENTS  
 MILLET YIELDS (G) FOR SPACINGS OF 2, 4, 6, 8 AND 10 INCHES  
 ANOVA with PROC GLM - Latin Square  
 The GLM Procedure

## Class Level Information

Class	Levels	Values
ROW	5	1 2 3 4 5
COLUMN	5	1 2 3 4 5
treatment	5	A B C D E

Number of observations 25

LATIN SQUARE WITH 5 ROWS, COLUMNS AND TREATMENTS  
 MILLET YIELDS (G) FOR SPACINGS OF 2, 4, 6, 8 AND 10 INCHES  
 ANOVA with PROC GLM - Latin Square

The GLM Procedure

Dependent Variable: YIELD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	12	23904.08000	1992.00667	1.89	0.1426
Error	12	12667.28000	1055.60667		
Corrected Total	24	36571.36000			

R-Square	Coeff Var	Root MSE	YIELD Mean
0.653628	12.88472	32.49010	252.1600

Source	DF	Type I SS	Mean Square	F Value	Pr > F
ROW	4	13601.36000	3400.34000	3.22	0.0516
COLUMN	4	6146.16000	1536.54000	1.46	0.2758
treatment	4	4156.56000	1039.14000	0.98	0.4523

Source	DF	Type III SS	Mean Square	F Value	Pr > F
ROW	4	13601.36000	3400.34000	3.22	0.0516
COLUMN	4	6146.16000	1536.54000	1.46	0.2758
treatment	4	4156.56000	1039.14000	0.98	0.4523

LATIN SQUARE WITH 5 ROWS, COLUMNS AND TREATMENTS  
 MILLET YIELDS (G) FOR SPACINGS OF 2, 4, 6, 8 AND 10 INCHES  
 ANOVA with PROC GLM - Latin Square

The GLM Procedure

Source	Type III Expected Mean Square
ROW	Var(Error) + 5 Var(ROW)
COLUMN	Var(Error) + 5 Var(COLUMN)
treatment	Var(Error) + Q(treatment)

```

345      **EXAMPLE 7*****;
346      *** Example of a series of Latin Squares      ***;
347      *** From my imagination                      ***;
348      *****;
349      OPTIONS PS=256 LS=111 NOCENTER NODATE NONUMBER;
350
351      data series;
352          Title1 'Example of a series of Latin Squares';
353      input square row col tmt $ y;
354      cards;

```

NOTE: The data set WORK.SERIES has 18 observations and 5 variables.

NOTE: DATA statement used:

```

real time      0.02 seconds
cpu time       0.02 seconds

```

373

```
;
```

374 proc print data=series; run;

NOTE: There were 18 observations read from the data set WORK.SERIES.

NOTE: The PROCEDURE PRINT printed page 51.

NOTE: PROCEDURE PRINT used:

```

real time      0.01 seconds
cpu time       0.01 seconds

```

#### Example of a series of Latin Squares

Obs	square	row	col	tmt	y
1	1	1	1	d	7
2	1	1	2	b	5
3	1	1	3	c	2
4	1	2	1	b	9
5	1	2	2	c	3
6	1	2	3	d	6
7	1	3	1	c	1
8	1	3	2	d	6
9	1	3	3	b	7
10	2	1	1	c	2
11	2	1	2	d	3
12	2	1	3	b	7
13	2	2	1	d	6
14	2	2	2	b	9
15	2	2	3	c	3
16	2	3	1	b	8
17	2	3	2	c	2
18	2	3	3	d	6

```

375      proc mixed data=series CL COVTEST; classes square row col tmt;
376          Title2 'ANOVA with PROC MIXED - Series of Latin Squares';
377      model y = tmt / outp=ResidDataP;
378      random square row(square) col(square) tmt*square;
379      LSMEANS tmt / pdiff adjust=tukey;
380      run;

```

NOTE: Convergence criteria met.

NOTE: Estimated G matrix is not positive definite.

NOTE: The data set WORK.RESIDDATA P has 18 observations and 12 variables.

NOTE: The PROCEDURE MIXED printed page 52.

NOTE: PROCEDURE MIXED used:

```

real time      0.20 seconds
cpu time       0.20 seconds

```

**Example of a series of Latin Squares****ANOVA with PROC MIXED - Series of Latin Squares****The Mixed Procedure****Model Information**

Data Set	WORK.SERIES
Dependent Variable	Y
Covariance Structure	Variance Components
Estimation Method	REML
Residual Variance Method	Profile
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Containment

**Class Level Information**

Class	Levels	Values
square	2	1 2
row	3	1 2 3
col	3	1 2 3
tmt	3	b c d

**Dimensions**

Covariance Parameters	5
Columns in X	4
Columns in Z	20
Subjects	1
Max Obs Per Subject	18
Observations Used	18
Observations Not Used	0
Total Observations	18

**Iteration History**

Iteration	Evaluations	-2 Res Log Like	Criterion
0	1	54.78369521	
1	2	54.53562480	0.00005865
2	1	54.53481396	0.00000009
3	1	54.53481275	0.00000000

Convergence criteria met.

**Covariance Parameter Estimates**

Cov Parm	Estimate	Standard Error	Z Value	Pr > Z	Alpha	Lower	Upper
square	0	.	.	.	.	.	.
row(square)	0.2433	0.5129	0.47	0.3176	0.05	0.03387	1079099
col(square)	0	.	.	.	.	.	.
square*tmt	0.1099	0.5327	0.21	0.4183	0.05	0.009602	3.445E35
Residual	1.2822	0.7115	1.80	0.0358	0.05	0.5468	5.7192

**Fit Statistics**

-2 Res Log Likelihood	54.5
AIC (smaller is better)	60.5
AICC (smaller is better)	62.7
BIC (smaller is better)	56.6

**Type 3 Tests of Fixed Effects**

Effect	Num DF	Den DF	F Value	Pr > F
tmt	2	2	27.33	0.0353

**Least Squares Means**

Effect	tmt	Estimate	Std Error	DF	t Value	Pr >  t
tmt	b	7.5000	0.5561	2	13.49	0.0055
tmt	c	2.1667	0.5561	2	3.90	0.0600
tmt	d	5.6667	0.5561	2	10.19	0.0095



## Differences of Least Squares Means

Effect	tmt	_tmt	Estimate	Standard Error	DF	t Value	Pr >  t	Adjustment	Adj P
tmt	b	c	5.3333	0.7330	2	7.28	0.0184	Tukey-Kramer	0.0334
tmt	b	d	1.8333	0.7330	2	2.50	0.1295	Tukey-Kramer	0.2258
tmt	c	d	-3.5000	0.7330	2	-4.77	0.0412	Tukey-Kramer	0.0742

```

381      proc univariate data=ResidDataP plot normal; var resid;
382          TITLE3 'Univariate analysis for PROC MIXED - Series of Latin
Squares';
383      run;

```

NOTE: The PROCEDURE UNIVARIATE printed page 53.

NOTE: PROCEDURE UNIVARIATE used:

```

      real time          0.03 seconds
      cpu time           0.03 seconds

```

## Example of a series of Latin Squares

ANOVA with PROC MIXED - Series of Latin Squares

Univariate analysis for PROC MIXED - Series of Latin Squares

## The UNIVARIATE Procedure

Variable: Resid

		Moments	
N	18	Sum Weights	18
Mean	0	Sum Observations	0
Std Deviation	0.97821613	Variance	0.9569068
Skewness	-1.0965374	Kurtosis	1.33159688
Uncorrected SS	16.2674156	Corrected SS	16.2674156
Coeff Variation	.	Std Error Mean	0.23056775

## Basic Statistical Measures

Location		Variability	
Mean	0.000000	Std Deviation	0.97822
Median	0.174784	Variance	0.95691
Mode	.	Range	3.59468
		Interquartile Range	0.71323

## Tests for Location: Mu0=0

Test	-Statistic-	-----p Value-----
Student's t	t 0	Pr >  t  1.0000
Sign	M 2	Pr >=  M  0.4807
Signed Rank	S 18.5	Pr >=  S  0.4423

## Tests for Normality

Test	--Statistic--	-----p Value-----
Shapiro-Wilk	W 0.884881	Pr < W 0.0316
Kolmogorov-Smirnov	D 0.220142	Pr > D 0.0211
Cramer-von Mises	W-Sq 0.130755	Pr > W-Sq 0.0405
Anderson-Darling	A-Sq 0.803675	Pr > A-Sq 0.0313

## Quantiles (Definition 5)

Quantile	Estimate
100% Max	1.358201
99%	1.358201
95%	1.358201
90%	1.279796
75% Q3	0.476755
50% Median	0.174784
25% Q1	-0.236477
10%	-2.127186
5%	-2.236477
1%	-2.236477
0% Min	-2.236477

Extreme Observations

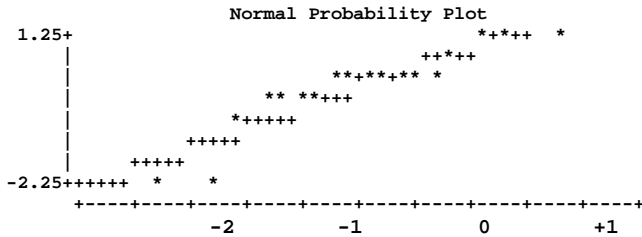
-----Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
-2.236477	2	0.476755	15
-2.127186	11	0.544942	5
-0.971331	7	1.075234	14
-0.281382	17	1.279796	4
-0.236477	9	1.358201	1

```

Stem Leaf
 1 134
 0 55
 0 012344
-0 3221
-0
-1 0
-1
-2 21
-----+-----+
    
```

```

# Boxplot
3 |
2 +-----+
6 *-----*
4 +-----+
|
1 |
2 0
    
```



+2

```

386      proc glm data=series; classes square row col tmt;
387          Title2 'ANOVA with PROC GLM - Series of Latin Squares with
PROC GLM';
388          model y = square row(square) col(square) tmt tmt*square;
389          random square row(square) col(square) tmt*square / test;
390      run;
    
```

NOTE: TYPE I EMS not available without the E1 option.

391

NOTE: The PROCEDURE GLM printed pages 54-57.

NOTE: PROCEDURE GLM used:

```

real time          0.08 seconds
cpu time           0.08 seconds
    
```

Example of a series of Latin Squares

ANOVA with PROC GLM - Series of Latin Squares with PROC GLM

The GLM Procedure

Class Level Information

Class	Levels	Values
square	2	1 2
row	3	1 2 3
col	3	1 2 3
tmt	3	b c d
Number of observations		18

Dependent Variable: y

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	13	104.6666667	8.0512821	4.53	0.0780
Error	4	7.1111111	1.7777778		
Corrected Total	17	111.7777778			

```

R-Square          Coeff Var      Root MSE          y Mean
0.936382          26.08696      1.333333          5.111111
    
```

Source	DF	Type I SS	Mean Square	F Value	Pr > F
square	1	0.0000000	0.0000000	0.00	1.0000
row(square)	4	9.7777778	2.4444444	1.38	0.3826
col(square)	4	2.4444444	0.6111111	0.34	0.8372
tmt	2	88.1111111	44.0555556	24.78	0.0056
square*tmt	2	4.3333333	2.1666667	1.22	0.3861

Source	DF	Type III SS	Mean Square	F Value	Pr > F
square	1	0.00000000	0.00000000	0.00	1.0000
row(square)	4	9.77777778	2.44444444	1.38	0.3826
col(square)	4	2.44444444	0.61111111	0.34	0.8372
tmt	2	88.11111111	44.05555556	24.78	0.0056
square*tmt	2	4.33333333	2.16666667	1.22	0.3861

Source	Type III Expected Mean Square
square	Var(Error) + 3 Var(square*tmt) + 3 Var(col(square)) + 3 Var(row(square)) + 9 Var(square)
row(square)	Var(Error) + 3 Var(row(square))
col(square)	Var(Error) + 3 Var(col(square))
tmt	Var(Error) + 3 Var(square*tmt) + Q(tmt)
square*tmt	Var(Error) + 3 Var(square*tmt)

### Tests of Hypotheses for Mixed Model Analysis of Variance

Dependent Variable: y

Source	DF	Type III SS	Mean Square	F Value	Pr > F
square	1	7.345736E-31	7.345736E-31	0.00	1.0000
Error	0.3915	0.652529	1.666667		
Error: MS(row(square)) + MS(col(square)) + MS(square*tmt) - 2*MS(Error)					

Source	DF	Type III SS	Mean Square	F Value	Pr > F
row(square)	4	9.7777778	2.4444444	1.38	0.3826
col(square)	4	2.4444444	0.6111111	0.34	0.8372
square*tmt	2	4.3333333	2.1666667	1.22	0.3861
Error: MS(Error)	4	7.1111111	1.7777778		

Source	DF	Type III SS	Mean Square	F Value	Pr > F
tmt	2	88.111111	44.055556	20.33	0.0469
Error	2	4.3333333	2.166667		
Error: MS(square*tmt)					