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OPTIONS LS=80 PS=66 MPRINT NODATE PAGENO=1 NOCENTER;
*-----;
FILENAME file1 URL "http://www.uvm.edu/~rsingle/stat231/data/kuehl/exp14_1.txt";
* http://www.uvm.edu/sasdoc/stat/chap30/sect23.htm#glmtest [***see Caution***] ;

DATA a1;
  INFILE file1 FIRSTOBS=2 EXPANDTABS;
  INPUT block nitro thatch chlorophyl;
  RUN;

*Method 2 - Complete or Incomplete Blocks;
PROC GLM DATA=a1;
  CLASS block nitro thatch;
  MODEL chlorophyl = block nitro block*nitro thatch nitro*thatch;
  RANDOM block block*nitro / TEST;
  ESTIMATE 'T1vT2' thatch 1 -1 0; *CORRECT SE;
  ESTIMATE 'N1vN2' nitro 1 -1 0 0; *WRONG SE;
  CONTRAST 'T1vT2' thatch 1 -1 0; *CORRECT TEST;
  CONTRAST 'N1vN2 (2)' nitro 1 -1 0 0; *WRONG TEST;
  CONTRAST 'N1vN2 (1)' nitro 1 -1 0 0 / E=block*nitro; *CORRECT TEST;

  *N1 N2 N3 N4 ;
  *T1 T2 T3 T1 T2 T3 T1 T2 T3 T1 T2 T3;
  ESTIMATE 'N1vN2@T1' nitro 1 -1 0 0 nitro*thatch 1 0 0 -1 0 0 0 0 0 0 0 0;
  CONTRAST 'N1vN2@T1' nitro 1 -1 0 0 nitro*thatch 1 0 0 -1 0 0 0 0 0 0 0 0;
  RUN;
  QUIT;

```

Dependent Variable: chlorophyl

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	15	47.06291667	3.13752778	14.62	0.0003
Error	8	1.71666667	0.21458333		
Corrected Total	23	48.77958333			

R-Square	Coeff Var	Root MSE	chlorophyl Mean
0.964808	7.290199	0.463231	6.354167

Source	DF	Type III SS	Mean Square	F Value	Pr > F
block	1	0.51041667	0.51041667	2.38	0.1616
nitro	3	37.32458333	12.44152778	57.98	<.0001
block*nitro	3	1.25791667	0.41930556	1.95	0.1996
thatch	2	3.81583333	1.90791667	8.89	0.0093
nitro*thatch	6	4.15416667	0.69236111	3.23	0.0646

Source	Type III Expected Mean Square
block	Var(Error) + 3 Var(block*nitro) + 12 Var(block)
nitro	Var(Error) + 3 Var(block*nitro) + Q(nitro,nitro*thatch)
block*nitro	Var(Error) + 3 Var(block*nitro)
thatch	Var(Error) + Q(thatch,nitro*thatch)
nitro*thatch	Var(Error) + Q(nitro*thatch)

Estimates

Parameter	Estimate	StandardError	t Value	Pr > t
T1 vs. T2	-0.62500000	0.23161570	-2.70	0.0271 *CORRECT SE
N1 vs. N2	-0.98333333	0.26744678	-3.68	0.0062 *WRONG SE
(N1 vs. N2)@T1	-1.75000000	0.46323140	-3.78	0.0054 *WRONG SE

Contrasts

Contrast	DF	ContrastSS	MeanSquare	F Value	Pr > F
T1 vs. T2	1	1.562500	1.562500	7.28	0.0271 *CORRECT TEST
N1 vs. N2 (2) [using Err2]	1	2.900833	2.900833	13.52	0.0060 *WRONG TEST
N1 vs. N2 (1) [using Err1]	1	2.900833	2.900833	6.92	0.0783 *CORRECT TEST @@
(N1 vs. N2)@T1	1	3.062500	3.062500	14.27	0.0054 *WRONG TEST

@@Using the Type III MS for block*nitro as an Error Term

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PROC MIXED DATA=a1;
  CLASS block nitro thatch ;
  MODEL chlorophyl = block nitro thatch thatch*nitro / DDFM=SATTERTH;
  RANDOM block*nitro;
  ESTIMATE 'N1vN2' nitro 1 -1 0 0; *CORRECT SE;
  ESTIMATE 'T1vT2' thatch 1 -1 0; *CORRECT SE;

  CONTRAST ' N1 vs. N2' nitro 1 -1 0 0; *CORRECT TEST;
  CONTRAST ' T1 vs. T2' thatch 1 -1 0; *CORRECT TEST;

  *N1 N2 N3 N4 ;
  *T1 T2 T3 T1 T2 T3 T1 T2 T3 T1 T2 T3;
  ESTIMATE 'N1vN2@T1' nitro 1 -1 0 0 nitro*thatch 1 0 0 -1 0 0 0 0 0 0 0 0;
  CONTRAST 'N1vN2@T1' nitro 1 -1 0 0 nitro*thatch 1 0 0 -1 0 0 0 0 0 0 0 0;
  RUN;

```

The Mixed Procedure

Dependent Variable	chlorophyl
Covariance Structure	Variance Components
Estimation Method	REML
Degrees of Freedom Method	Satterthwaite

Class	Levels	Values
block	2	1 2
nitro	4	1 2 3 4
thatch	3	1 2 3

Dimensions

Covariance Parameters	2
Columns in X	22
Columns in Z	8

Iteration History

Iteration	Evaluations	-2 Res Log Like	Criterion
0	1	26.94046907	
1	1	26.40625032	0.00000000

Convergence criteria met.

Covariance Parameter Estimates

Cov Parm	Estimate
block*nitro	0.06824
Residual	0.2146

Type 3 Tests of Fixed Effects

Effect	NumDF	DenDF	F Value	Pr > F
block	1	3	1.22	0.3505
nitro	3	3	29.67	0.0099
thatch	2	8	8.89	0.0093
nitro*thatch	6	8	3.23	0.0646

Estimates

Label	Estimate	StandardError	DF	t Value	Pr > t
T1 vs. T2	-0.6250	0.2316	8	-2.70	0.0271
N1 vs. N2	-0.9833	0.3739	3	-2.63	0.0783
(N1 vs. N2)@T1	-1.7500	0.5318	8.82	-3.29	0.0096

Contrasts

Label	NumDF	DenDF	F Value	Pr > F
T1 vs. T2	1	8	7.28	0.0271
N1 vs. N2	1	3	6.92	0.0783
(N1 vs. N2)@T1	1	8.82	10.83	0.0096