

```

data one;
  input variety fert yield;
  cards;
1 1 37
1 1 40
1 1 45
1 1 46
1 2 47
1 2 45
1 2 42
1 2 40
2 1 40
2 1 43
2 1 47
2 1 42
2 2 37
2 2 47
2 2 41
2 2 47
3 1 41
3 1 46
3 1 52
3 1 45
3 2 51
3 2 55
3 2 52
3 2 57
;

proc glm;
  class variety fert;
  model yield=variety fert variety*fert / clparm;
  lsmeans variety / adjust=tukey pdiff cl;
  estimate 'Fertilizer 1 - Fertilizer 2' fert 1 -1;
run;

```

**The GLM Procedure**  
**Class Level Information**  

Class	Levels	Values
variety	3	1 2 3
fert	2	1 2
Number of observations		24

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	386.2083333	77.2416667	5.23	0.0039
Error	18	265.7500000	14.7638889		
Corrected Total	23	651.9583333			

R-Square	Coeff Var	Root MSE	yield Mean
0.592382	8.499275	3.842381	45.20833

Source	DF	Type I SS	Mean Square	F Value	Pr > F
variety	2	261.5833333	130.7916667	8.86	0.0021
fert	1	57.0416667	57.0416667	3.86	0.0650
variety*fert	2	67.5833333	33.7916667	2.29	0.1301

Source	DF	Type III SS	Mean Square	F Value	Pr > F
variety	2	261.5833333	130.7916667	8.86	0.0021
fert	1	57.0416667	57.0416667	3.86	0.0650
variety*fert	2	67.5833333	33.7916667	2.29	0.1301

Least Squares Means  
Adjustment for Multiple Comparisons: Tukey

variety	yield LSMEAN	LSMEAN Number
1	42.7500000	1
2	43.0000000	2
3	49.8750000	3

Least Squares Means for effect variety  
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: yield

i/j	1	2	3
1		0.9907	0.0044
2	0.9907		0.0058
3	0.0044	0.0058	

variety	yield LSMEAN	95% Confidence Limits	
1	42.750000	39.895925	45.604075
2	43.000000	40.145925	45.854075
3	49.875000	47.020925	52.729075

Least Squares Means for Effect variety

i	j	Difference Between Means	Simultaneous 95% Confidence Limits for LSMean(i) - LSMean(j)	
1	2	-0.250000	-5.153192	4.653192
1	3	-7.125000	-12.028192	-2.221808
2	3	-6.875000	-11.778192	-1.971808

Parameter	Estimate	Standard Error	t Value	Pr >  t
Fertilizer 1 - Fertilizer 2	-3.0833333	1.56864532	-1.97	0.0650

Parameter	95% Confidence Limits	
Fertilizer 1 - Fertilizer 2	-6.37893486	0.21226820

```

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  input variety fert yield;
  cards;
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1 1 41
1 1 39
1 2 47
1 2 45
1 2 42
1 2 46
2 1 40
2 1 43
2 1 47
2 1 42
2 2 37
2 2 47
2 2 41
2 2 43
3 1 51
3 1 56
3 1 52
3 1 45
3 2 41
3 2 45
3 2 42
3 2 47
;

proc glm;
  class variety fert;
  model yield=variety fert variety*fert / solution clparm;
  lsmeans variety*fert / slice=variety;
  estimate 'Fert 1 - Fert 2 for Variety 1' fert 1 -1 variety*fert 1 -1 0 0 0 0;
  estimate 'Fert 1 - Fert 2 for Variety 2' fert 1 -1 variety*fert 0 0 1 -1 0 0;
  estimate 'Fert 1 - Fert 2 for Variety 3' fert 1 -1 variety*fert 0 0 0 0 1 -1;
run;

```

The GLM Procedure  
Class Level Information

Class	Levels	Values
variety	3	1 2 3
fert	2	1 2
Number of observations		24

Dependent Variable: yield

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	310.5000000	62.1000000	6.03	0.0019
Error	18	185.5000000	10.3055556		
Corrected Total	23	496.0000000			

Source	DF	Type I SS	Mean Square	F Value	Pr > F
variety	2	137.2500000	68.6250000	6.66	0.0068
fert	1	4.1666667	4.1666667	0.40	0.5329
variety*fert	2	169.0833333	84.5416667	8.20	0.0029

Source	DF	Type III SS	Mean Square	F Value	Pr > F
variety	2	137.2500000	68.6250000	6.66	0.0068
fert	1	4.1666667	4.1666667	0.40	0.5329
variety*fert	2	169.0833333	84.5416667	8.20	0.0029

Parameter		Estimate	Standard Error	t Value	Pr >  t	95% Confidence Limits	
Intercept		43.75000000 B	1.60511336	27.26	<.0001	40.37778197	47.12221803
variety	1	1.25000000 B	2.26997308	0.55	0.5886	-3.51903647	6.01903647
variety	2	-1.75000000 B	2.26997308	-0.77	0.4507	-6.51903647	3.01903647
variety	3	0.00000000 B	.	.	.	.	.
fert	1	7.25000000 B	2.26997308	3.19	0.0050	2.48096353	12.01903647
fert	2	0.00000000 B	.	.	.	.	.
variety*fert	1 1	-13.00000000 B	3.21022671	-4.05	0.0008	-19.74443606	-6.25556394
variety*fert	1 2	0.00000000 B	.	.	.	.	.
variety*fert	2 1	-6.25000000 B	3.21022671	-1.95	0.0673	-12.99443606	0.49443606
variety*fert	2 2	0.00000000 B	.	.	.	.	.
variety*fert	3 1	0.00000000 B	.	.	.	.	.
variety*fert	3 2	0.00000000 B	.	.	.	.	.

NOTE: The X'X matrix has been found to be singular, and a generalized inverse was used to solve the normal equations. Terms whose estimates are followed by the letter 'B' are not uniquely estimable.

Least Squares Means		
variety	fert	yield LSMEAN
1	1	39.2500000
1	2	45.0000000
2	1	43.0000000
2	2	42.0000000
3	1	51.0000000
3	2	43.7500000

variety\*fert Effect Sliced by variety for yield

variety	DF	Sum of Squares	Mean Square	F Value	Pr > F
1	1	66.125000	66.125000	6.42	0.0208
2	1	2.000000	2.000000	0.19	0.6648
3	1	105.125000	105.125000	10.20	0.0050

Parameter	Estimate	Standard Error	t Value	Pr >  t
Fert 1 - Fert 2 for Variety 1	-5.75000000	2.26997308	-2.53	0.0208
Fert 1 - Fert 2 for Variety 2	1.00000000	2.26997308	0.44	0.6648
Fert 1 - Fert 2 for Variety 3	7.25000000	2.26997308	3.19	0.0050

Parameter	95% Confidence Limits	
Fert 1 - Fert 2 for Variety 1	-10.51903647	-0.98096353
Fert 1 - Fert 2 for Variety 2	-3.76903647	5.76903647
Fert 1 - Fert 2 for Variety 3	2.48096353	12.01903647