

SAS 入門講義 (實作)

一、完全逢機設計(CRD)試驗：

試驗人員將苜蓿在 5 種不同培養基中進行培養，每一培養基組重複 4 次，欲瞭解苜蓿培養一個月後其氮素含量之變化，應如何進行單因子 CRD 變方分析，並比較各培養基組的平均氮素含量。

	重複 1	重複 2	重複 3	重複 4
A	29.4	32.6	27.0	32.1
B	17.7	24.8	27.9	25.2
C	17.0	15.6	9.1	11.9
D	20.4	21.0	20.5	18.8
E	14.3	14.5	11.8	11.6

SAS 程式語法:

```
DATA CRD;
INPUT STRAIN$ NITROGEN @@;
CARDS;
A 29.4 A 32.6 A 27.0 A 32.1
B 17.7 B 24.8 B 27.9 B 25.2
C 17.0 C 15.6 C 9.1 C 11.9
D 20.4 D 21.0 D 20.5 D 18.8
E 14.3 E 14.5 E 11.8 E 11.6
;
PROC ANOVA;
CLASS STRAIN;
MODEL NITROGEN=STRAIN;
MEANS STRAIN/LSD;
RUN;
```

```
或者用另一種輸入格式：
INPUT STRAIN$ REP NITROGEN;
CARDS;
A 1 29.4
A 2 32.6
A 3 27.0
A 4 32.1
B 1 17.7
B 2 24.8
B 3 27.9
.
. (略)
.
;
```

完全隨機設計(CRD)試驗 - 執行結果：

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Class Level Information

Class	Levels	Values
STRAIN	5	A B C D E ← 處理試因變數 數目及其變級代號說明
Number of observations		20 ← 觀測值總個數

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 The ANOVA Procedure

Dependent Variable: NITROGEN ← 依變數(調查性狀)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	850.2030000	212.5507500	25.35	<.0001
Error	15 ← 機差自由度	125.7650000	8.3843333 ← 機差均方		
Corrected Total	19	975.9680000			

CV 值

R-Square	Coeff Var	Root MSE	NITROGEN Mean
0.871138	14.36295	2.895571	20.16000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
STRAIN	4 ← 試因自由度	850.2030000	212.5507500	25.35	<.0001 ← 試因均方 <0.01, 處理間極顯著差異

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The ANOVA Procedure

t Tests (LSD) for NITROGEN

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05	← α 顯著水準 (SAS 內設值)
Error Degrees of Freedom	15	
Error Mean Square	8.384333	
Critical Value of t	2.13145	
Least Significant Difference	4.3641	← 臨界 LSD(0.05) 值

Means with the same letter are not significantly different.

t Grouping	Mean	N	STRAIN
A	30.275	4	A
B	23.900	4	B
B	20.175	4	D
C	13.400	4	C
C	13.050	4	E

顯著差異以不同字母表示
 平均值 (遞減排序)
 重複次數
 試因各變級代號

A 培養基的氮素含量顯著最高，其次為 B 和 C 培養基，而以 C 和 E 培養基顯著最低

二、逢機完全區集設計(RCBD)試驗：

現有 3 個秈稻新育成品系在 2 種不同處理下所進行試驗的產量資料，試驗採 RCBD 設計，4 重複(區集)，應如何用 ANOVA 程序執行複因子 RCBD 變方分析，以探討品系與處理間交感是否存在，並比較各品系的平均產量之表現差異。

品系	處理別	重複 1	處理別	重複 2	處理別	重複 3	處理別	重複 4
A	1	4500	1	4609	1	4370	1	4902
A	2	4366	2	4560	2	4820	2	4019
B	1	3510	1	3820	1	3899	1	3650
B	2	4572	2	4750	2	4320	2	4519
C	1	4851	1	5015	1	4935	1	4760
C	2	4529	2	4750	2	4290	2	4560

SAS 程式語法:

```
DATA RCBD;
INPUT VARIETY$ TREAT$ BLOCK$ YIELD @@;
CARDS;
A 1 1 4500 A 1 2 4609 A 1 3 4370 A 1 4 4902
A 2 1 4366 A 2 2 4560 A 2 3 4820 A 2 4 4019
B 1 1 3510 B 1 2 3820 B 1 3 3899 B 1 4 3650
B 2 1 4572 B 2 2 4750 B 2 3 4320 B 2 4 4519
C 1 1 4851 C 1 2 5015 C 1 3 4935 C 1 4 4760
C 2 1 4529 C 2 2 4750 C 2 3 4290 C 2 4 4560
;
PROC ANOVA;
CLASS VARIETY TREAT BLOCK;
MODEL YIELD=BLOCK VARIETY TREAT VARIETY*TREAT;
MEANS VARIETY TREAT /LSD; *當 VARIETY 和 TREAT 交感不顯著時;
PROC ANOVA; *當 VARIETY 和 TREAT 交感顯著時分別比較 VARIETY 與 TREAT;
CLASS TREAT BLOCK;
MODEL YIELD=TREAT BLOCK;
MEANS TREAT/LSD;
BY VARIETY;
PROC SORT;
BY TREAT VARIETY;
PROC ANOVA;
CLASS VARIETY BLOCK;
MODEL YIELD=VARIETY BLOCK;
MEANS VARIETY/LSD;
BY TREAT;
RUN;
```

逢機完全區集設計(RCBD)試驗-執行結果：

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The ANOVA Procedure
Class Level Information

Class	Levels	Values
VARIETY	3	A B C
TREAT	2	1 2
BLOCK	4	1 2 3 4

Number of observations 24

The SAS System

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The ANOVA Procedure

Dependent Variable: YIELD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	3197738.833	399717.354	8.84	0.0002
Error	15	678260.500	45217.367		
Corrected Total	23	3875999.333			

R-Square 0.825010
Coeff Var 4.775113
Root MSE 212.6438
YIELD Mean 4453.167

Source	DF	Anova SS	Mean Square	F Value	Pr > F
BLOCK	3	145302.000	48434.000	1.07	0.3909
VARIETY	2	1402236.333	701118.167	15.51	0.0002
TREAT	1	63448.167	63448.167	1.40	0.2546
VARIETY*TREAT	2	1586752.333	793376.167	17.55	0.0001

>0.05, 處理間差異不顯著

<0.01, 品種間極顯著差異

<0.01, 交感效應極顯著

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The ANOVA Procedure
t Tests (LSD) for YIELD

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha 0.05
 Error Degrees of Freedom 15
 Error Mean Square 45217.37
 Critical Value of t 2.13145
 Least Significant Difference 226.62

Means with the same letter are not significantly different.

t Grouping	Mean	N	VARIETY
A	4711.3	8	C
A			
A	4518.3	8	A
B	4130.0	8	B

品種間個別差異顯著性結果，但因為交感效應顯著存在，此處僅考慮主效應是沒有意義的，不能採用此結果

The SAS System

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The ANOVA Procedure

t Tests (LSD) for YIELD

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha 0.05
 Error Degrees of Freedom 15
 Error Mean Square 45217.37
 Critical Value of t 2.13145
 Least Significant Difference 185.03

Means with the same letter are not significantly different.

t Grouping	Mean	N	TREAT
A	4504.58	12	2
A			
A	4401.75	12	1

處理間個別差異顯著性結果，但因為交感效應顯著存在，此處僅考慮主效應是沒有意義的，不能採用此結果

----- VARIETY=A -----

The ANOVA Procedure

Class Level Information

Class	Levels	Values
TREAT	2	1 2
BLOCK	4	1 2 3 4

Number of observations 8

----- VARIETY=A -----

The ANOVA Procedure

Dependent Variable: YIELD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	89196.5000	22299.1250	0.15	0.9523
Error	3	453841.0000	151280.3333		
Corrected Total	7	543037.5000			

R-Square	Coeff Var	Root MSE	YIELD Mean
0.164255	8.608371	388.9477	4518.250

Source	DF	Anova SS	Mean Square	F Value	Pr > F
TREAT	1	47432.00000	47432.00000	0.31	0.6146
BLOCK	3	41764.50000	13921.50000	0.09	0.9595

----- VARIETY=A -----

The ANOVA Procedure

t Tests (LSD) for YIELD

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	3
Error Mean Square	151280.3
Critical Value of t	3.18245
Least Significant Difference	875.26

Means with the same letter are not significantly different.

t Grouping	Mean	N	TREAT
A	4595.3	4	1
A			
A	4441.3	4	2

← A 品種在不同處理間
差異不顯著

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----- VARIETY=B -----

The ANOVA Procedure

Class Level Information

Class	Levels	Values
TREAT	2	1 2
BLOCK	4	1 2 3 4

Number of observations 8

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----- VARIETY=B -----

The ANOVA Procedure

Dependent Variable: YIELD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	1415313.500	353828.375	9.14	0.0498
Error	3	116132.500	38710.833		
Corrected Total	7	1531446.000			

R-Square	Coeff Var	Root MSE	YIELD Mean
0.924168	4.763939	196.7507	4130.000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
TREAT	1	1346440.500	1346440.500	34.78	0.0097
BLOCK	3	68873.000	22957.667	0.59	0.6608

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----- VARIETY=B -----

The ANOVA Procedure

t Tests (LSD) for YIELD

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	3
Error Mean Square	38710.83
Critical Value of t	3.18245
Least Significant Difference	442.75

Means with the same letter are not significantly different.

t Grouping	Mean	N	TREAT
A	4540.3	4	2
B	3719.8	4	1

← B 品種在不同處理間有顯著，以處理 2 較優

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----- VARIETY=C -----

The ANOVA Procedure

Class Level Information

Class	Levels	Values
TREAT	2	1 2
BLOCK	4	1 2 3 4

Number of observations 8

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----- VARIETY=C -----

The ANOVA Procedure

Dependent Variable: YIELD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	340640.5000	85160.1250	4.36	0.1283
Error	3	58639.0000	19546.3333		
Corrected Total	7	399279.5000			

R-Square	Coeff Var	Root MSE	YIELD Mean
0.853138	2.967539	139.8082	4711.250

Source	DF	Anova SS	Mean Square	F Value	Pr > F
TREAT	1	256328.0000	256328.0000	13.11	0.0362
BLOCK	3	84312.5000	28104.1667	1.44	0.3863

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----- VARIETY=C -----

The ANOVA Procedure

t Tests (LSD) for YIELD

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	3
Error Mean Square	19546.33
Critical Value of t	3.18245
Least Significant Difference	314.61

Means with the same letter are not significantly different.

t Grouping	Mean	N	TREAT
A	4890.25	4	1
B	4532.25	4	2

← C 品種在不同處理間有顯著，以處理 1 較優

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----- TREAT=1 -----

The ANOVA Procedure
Class Level Information

Class	Levels	Values
VARIETY	3	A B C
BLOCK	4	1 2 3 4

Number of observations	12
------------------------	----

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----- TREAT=1 -----

The ANOVA Procedure

Dependent Variable: YIELD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	3027096.250	605419.250	16.59	0.0019
Error	6	218904.000	36484.000		
Corrected Total	11	3246000.250			

R-Square	Coeff Var	Root MSE	YIELD Mean
0.932562	4.339362	191.0079	4401.750

Source	DF	Anova SS	Mean Square	F Value	Pr > F
VARIETY	2	2964794.000	1482397.000	40.63	0.0003
BLOCK	3	62302.250	20767.417	0.57	0.6555

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----- TREAT=1 -----

The ANOVA Procedure

t Tests (LSD) for YIELD

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6

Error Mean Square 36484
 Critical Value of t 2.44691
 Least Significant Difference 330.49

Means with the same letter are not significantly different.

t Grouping	Mean	N	VARIETY
A	4890.3	4	C
A			
A	4595.3	4	A
B	3719.8	4	B

← 處理1 下以品種C 和A
最優且無顯著差異，而
品種B 則顯著較差

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----- TREAT=2 -----

The ANOVA Procedure

Class Level Information

Class	Levels	Values
VARIETY	3	A B C
BLOCK	4	1 2 3 4

Number of observations 12

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----- TREAT=2 -----

The ANOVA Procedure

Dependent Variable: YIELD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	184340.2500	36868.0500	0.58	0.7175
Error	6	382210.6667	63701.7778		
Corrected Total	11	566550.9167			

R-Square	Coeff Var	Root MSE	YIELD Mean
0.325373	5.603007	252.3921	4504.583

Source	DF	Anova SS	Mean Square	F Value	Pr > F
VARIETY	2	24194.6667	12097.3333	0.19	0.8318
BLOCK	3	160145.5833	53381.8611	0.84	0.5205

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----- TREAT=2 -----

The ANOVA Procedure

t Tests (LSD) for YIELD

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	63701.78
Critical Value of t	2.44691
Least Significant Difference	436.7

Means with the same letter are not significantly different.

t Grouping	Mean	N	VARIETY
A	4540.3	4	B
A			
A	4532.3	4	C
A			
A	4441.3	4	A

← 處理2 下三個品種間
皆無顯著差異

三、裂區設計(SPD)試驗:

現有 3 個作物新育成品系進行兩種不同肥料處理試驗，試驗者採用裂區設計(split plot design)，以肥料為大區(主區)，品系為小區(副區)，4 重複，請探討品系與肥料間交感效應，並比較各品系平均產量及不同肥料等級間的差異性。

1. 請繪出此試驗之田間佈置圖。
2. 本試驗數據同前面 RCBD 資料。

2	1	2	1	1	2	1	2
A	C	B	A	C	A	B	A
C	B	A	C	B	B	A	C
B	A	C	B	A	C	C	B

SAS 程式語法:

```

DATA SPLIT;
INFILE 'A:SPDDEMO.DAT';
INPUT VARIETY$ TREAT$ BLOCK$ YIELD @@;
PROC ANOVA;
  CLASS VARIETY TREAT BLOCK;
  MODEL YIELD=BLOCK TREAT BLOCK*TREAT VARIETY VARIETY*TREAT;
  TEST H=TREAT E=BLOCK*TREAT;
  MEANS VARIETY/LSD;
  MEANS TREAT/LSD E=BLOCK*TREAT; *當 VARIETY 和 TREAT 交感不顯著時;
PROC ANOVA; *當 VARIETY 和 TREAT 交感顯著時分別比較 VARIETY 與 TREAT;
  CLASS TREAT BLOCK;
  MODEL YIELD=TREAT BLOCK;
  MEANS TREAT/LSD;
  BY VARIETY;
PROC SORT;
  BY TREAT VARIETY;
PROC ANOVA;
  CLASS VARIETY BLOCK;
  MODEL YIELD=VARIETY BLOCK;
  MEANS VARIETY/LSD;
  BY TREAT;
RUN;

```

裂區設計(SPD)試驗 - 執行結果:

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The ANOVA Procedure

Class Level Information

Class	Levels	Values
VARIETY	3	A B C
TREAT	2	1 2
BLOCK	4	1 2 3 4

Number of observations 24

The SAS System

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The ANOVA Procedure

Dependent Variable: YIELD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	3274884.667	297716.788	5.94	0.0023
Error	12	601114.667	50092.889		
Corrected Total	23	3875999.333			

R-Square 0.844914 Coeff Var 5.025961 Root MSE 223.8144 YIELD Mean 4453.167

Source	DF	Anova SS	Mean Square	F Value	Pr > F
BLOCK	3	145302.000	48434.000	0.97	0.4401
TREAT	1	63448.167	63448.167	1.27	0.2824
TREAT*BLOCK	3	77145.833	25715.278	0.51	0.6807
VARIETY	2	1402236.333	701118.167	14.00	0.0007
VARIETY*TREAT	2	1586752.333	793376.167	15.84	0.0004

$(4-1) \times (2-1) = 3$
主區機差

<0.01, 品種間差異極顯著

<0.01, 交感效應極顯著存在

Tests of Hypotheses Using the Anova MS for TREAT*BLOCK as an Error Term

Source	DF	Anova SS	Mean Square	F Value	Pr > F
TREAT	1	63448.16667	63448.16667	2.47	0.2143

>0.05, 處理間差異不顯著 (F 測驗中以主區機差為分母)

The ANOVA Procedure
t Tests (LSD) for YIELD

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	12
Error Mean Square	50092.89
Critical Value of t	2.17881
Least Significant Difference	243.82

Means with the same letter are not significantly different.

t Grouping	Mean	N	VARIETY
A	4711.3	8	C
A			
A	4518.3	8	A
B	4130.0	8	B

處理間個別差異顯著性結果，但因為交感效應顯著存在，此處僅考慮主效應是沒有意義的，不能採用此結果

The ANOVA Procedure
t Tests (LSD) for YIELD

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	3
Error Mean Square	25715.28
Critical Value of t	3.18245
Least Significant Difference	208.34

Means with the same letter are not significantly different.

t Grouping	Mean	N	TREAT
A	4504.58	12	2
A			
A	4401.75	12	1

處理間個別差異顯著性結果，但因為交感效應顯著存在，此處僅考慮主效應是沒有意義的，不能採用此結果

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----- VARIETY=A -----

The ANOVA Procedure

Class Level Information

Class	Levels	Values
TREAT	2	1 2
BLOCK	4	1 2 3 4

Number of observations 8

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----- VARIETY=A -----

The ANOVA Procedure

Dependent Variable: YIELD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	89196.5000	22299.1250	0.15	0.9523
Error	3	453841.0000	151280.3333		
Corrected Total	7	543037.5000			

R-Square	Coeff Var	Root MSE	YIELD Mean
0.164255	8.608371	388.9477	4518.250

Source	DF	Anova SS	Mean Square	F Value	Pr > F
TREAT	1	47432.00000	47432.00000	0.31	0.6146
BLOCK	3	41764.50000	13921.50000	0.09	0.9595

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----- VARIETY=A -----

The ANOVA Procedure

t Tests (LSD) for YIELD

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha

0.05

Error Degrees of Freedom	3
Error Mean Square	151280.3
Critical Value of t	3.18245
Least Significant Difference	875.26

Means with the same letter are not significantly different.

t Grouping	Mean	N	TREAT
A	4595.3	4	1
A			
A	4441.3	4	2

品種 A 在不同處理間
← 無顯著差異

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----- VARIETY=B -----

The ANOVA Procedure

Class Level Information

Class	Levels	Values
TREAT	2	1 2
BLOCK	4	1 2 3 4

Number of observations 8

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----- VARIETY=B -----

The ANOVA Procedure

Dependent Variable: YIELD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	1415313.500	353828.375	9.14	0.0498
Error	3	116132.500	38710.833		
Corrected Total	7	1531446.000			

R-Square	Coeff Var	Root MSE	YIELD Mean
0.924168	4.763939	196.7507	4130.000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
TREAT	1	1346440.500	1346440.500	34.78	0.0097

BLOCK	3	68873.000	22957.667	0.59	0.6608
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----- VARIETY=B -----

The ANOVA Procedure

t Tests (LSD) for YIELD

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	3
Error Mean Square	38710.83
Critical Value of t	3.18245
Least Significant Difference	442.75

Means with the same letter are not significantly different.

t Grouping	Mean	N	TREAT
A	4540.3	4	2
B	3719.8	4	1

← 品種 B 以處理 2 優於處理 1

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----- VARIETY=C -----

The ANOVA Procedure

Class Level Information

Class	Levels	Values
TREAT	2	1 2
BLOCK	4	1 2 3 4

Number of observations 8

The SAS System

95

13:47 Saturday, April 27, 2002

----- VARIETY=C -----

The ANOVA Procedure

Dependent Variable: YIELD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	340640.5000	85160.1250	4.36	0.1283
Error	3	58639.0000	19546.3333		
Corrected Total	7	399279.5000			

R-Square	Coeff Var	Root MSE	YIELD Mean
0.853138	2.967539	139.8082	4711.250

Source	DF	Anova SS	Mean Square	F Value	Pr > F
TREAT	1	256328.0000	256328.0000	13.11	0.0362
BLOCK	3	84312.5000	28104.1667	1.44	0.3863

The SAS System

96

13:47 Saturday, April 27, 2002

----- VARIETY=C -----

The ANOVA Procedure

t Tests (LSD) for YIELD

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	3
Error Mean Square	19546.33
Critical Value of t	3.18245
Least Significant Difference	314.61

Means with the same letter are not significantly different.

t Grouping	Mean	N	TREAT
A	4890.25	4	1
B	4532.25	4	2

← 品種 C 以處理 1 優於
處理 2

----- TREAT=1 -----

The ANOVA Procedure

Class Level Information

Class	Levels	Values
VARIETY	3	A B C
BLOCK	4	1 2 3 4

Number of observations 12

----- TREAT=1 -----

The ANOVA Procedure

Dependent Variable: YIELD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	3027096.250	605419.250	16.59	0.0019
Error	6	218904.000	36484.000		
Corrected Total	11	3246000.250			

R-Square	Coeff Var	Root MSE	YIELD Mean
0.932562	4.339362	191.0079	4401.750

Source	DF	Anova SS	Mean Square	F Value	Pr > F
VARIETY	2	2964794.000	1482397.000	40.63	0.0003
BLOCK	3	62302.250	20767.417	0.57	0.6555

----- TREAT=1 -----

The ANOVA Procedure

t Tests (LSD) for YIELD

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha

0.05

Error Degrees of Freedom	6
Error Mean Square	36484
Critical Value of t	2.44691
Least Significant Difference	330.49

Means with the same letter are not significantly different.

t Grouping	Mean	N	VARIETY
A	4890.3	4	C
A			
A	4595.3	4	A
B	3719.8	4	B

處理 1 下品種 C 與 A
較優且無顯著差異，
而品種 B 則顯著較差

The SAS System 100
13:47 Saturday, April 27, 2002

----- TREAT=2 -----

The ANOVA Procedure

Class Level Information

Class	Levels	Values
VARIETY	3	A B C
BLOCK	4	1 2 3 4

Number of observations 12

The SAS System 101
13:47 Saturday, April 27, 2002

----- TREAT=2 -----

The ANOVA Procedure

Dependent Variable: YIELD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	184340.2500	36868.0500	0.58	0.7175
Error	6	382210.6667	63701.7778		
Corrected Total	11	566550.9167			

R-Square	Coeff Var	Root MSE	YIELD Mean
0.325373	5.603007	252.3921	4504.583

Source	DF	Anova SS	Mean Square	F Value	Pr > F
VARIETY	2	24194.6667	12097.3333	0.19	0.8318
BLOCK	3	160145.5833	53381.8611	0.84	0.5205

The SAS System 102

13:47 Saturday, April 27, 2002

----- TREAT=2 -----

The ANOVA Procedure

t Tests (LSD) for YIELD

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	63701.78
Critical Value of t	2.44691
Least Significant Difference	436.7

Means with the same letter are not significantly different.

t Grouping	Mean	N	VARIETY
A	4540.3	4	B
A			
A	4532.3	4	C
A			
A	4441.3	4	A

← 處理 2 下三個品種間
皆無顯著差異

四、綜合變方分析(Combined ANOVA)：

現有兩個作物品種系(A, B, C)，進行二個年度的產量試驗，試驗採 RCBD 設計，四區集(重複)，如何以 SAS 程式進行綜合變方分析。

第一年試驗			
A	B	A	A
C	A	B	C
B	C	C	B

第二年試驗			
C	A	C	B
B	C	B	A
A	B	A	C

SAS 程式語法:

```
DATA COMBINED;
INFILE 'A:CANO.DAT';
INPUT YEAR $ VARIETY $ BLOCK $ YIELD @@;
PROC ANOVA; *先進行各年度的變方分析，若有顯著差異再進行綜合變方分析;
  BY YEAR;
  CLASS BLOCK VARIETY;
  MODEL YIELD=BLOCK VARIETY;
  MEANS VARIETY/LSD;
PROC ANOVA; *進行合併年度的綜合變方分析;
  CLASS YEAR VARIETY BLOCK;
  MODEL YIELD=BLOCK(YEAR) YEAR VARIETY YEAR*VARIETY;
  TEST H=YEAR E=BLOCK(YEAR); *進行年度的 F 檢定;
  MEANS VARIETY/LSD; *進行品種的平均值檢定;
  MEANS YEAR/LSD E=BLOCK(YEAR);
  MEANS YEAR*VARIETY;
RUN;
```

(此若是作物區域試驗，通常會再進行穩定性分析，各品種在不同年度的平均表現和穩定係數才是區域試驗的分析重點)

CANO.DAT輸入格式：

```
89 A 1 4500 89 A 2 4609 89 A 3 4370 89 A 4 4902
89 B 1 4366 89 B 2 4560 89 B 3 4820 89 B 4 4019
89 C 1 3510 89 C 2 3820 89 C 3 3899 89 C 4 3650
90 A 1 4572 90 A 2 4750 90 A 3 4320 90 A 4 4519
90 B 1 4851 90 B 2 5015 90 B 3 4935 90 B 4 4760
90 C 1 4529 90 C 2 4750 90 C 3 4290 90 C 4 4560
```


綜合變方分析(Combined ANOVA) - 執行結果：

The SAS System

109

13:47 Saturday, April 27, 2002

----- YEAR=89 -----

The ANOVA Procedure
Class Level Information

Class	Levels	Values
BLOCK	4	1 2 3 4
VARIETY	3	A B C

Number of observations 12

The SAS System

110

13:47 Saturday, April 27, 2002

----- YEAR=89 -----

The ANOVA Procedure

Dependent Variable: YIELD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	1862305.583	372461.117	4.73	0.0424
Error	6	472045.333	78674.222		
Corrected Total	11	2334350.917			

R-Square	Coeff Var	Root MSE	YIELD Mean
0.797783	6.596514	280.4893	4252.083

Source	DF	Anova SS	Mean Square	F Value	Pr > F
BLOCK	3	114600.917	38200.306	0.49	0.7046
VARIETY	2	1747704.667	873852.333	11.11	0.0096

The SAS System

111

13:47 Saturday, April 27, 2002

----- YEAR=89 -----

The ANOVA Procedure
t Tests (LSD) for YIELD

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha

0.05

Error Degrees of Freedom	6
Error Mean Square	78674.22
Critical Value of t	2.44691
Least Significant Difference	485.31

Means with the same letter are not significantly different.

t Grouping	Mean	N	VARIETY
A	4595.3	4	A
A			
A	4441.3	4	B
B	3719.8	4	C

在89年時A和B品種最優且無顯著差異，而C品種則顯著較差

The SAS System 112

13:47 Saturday, April 27, 2002

----- YEAR=90 -----

The ANOVA Procedure
Class Level Information

Class	Levels	Values
BLOCK	4	1 2 3 4
VARIETY	3	A B C

Number of observations 12

The SAS System 113

13:47 Saturday, April 27, 2002

----- YEAR=90 -----

The ANOVA Procedure

Dependent Variable: YIELD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	499278.9167	99855.7833	8.33	0.0113
Error	6	71941.3333	11990.2222		
Corrected Total	11	571220.2500			

R-Square	Coeff Var	Root MSE	YIELD Mean
0.874057	2.352686	109.4999	4654.250

Source	DF	Anova SS	Mean Square	F Value	Pr > F
BLOCK	3	164974.9167	54991.6389	4.59	0.0538
VARIETY	2	334304.0000	167152.0000	13.94	0.0056

The SAS System

114

13:47 Saturday, April 27, 2002

----- YEAR=90 -----

The ANOVA Procedure

t Tests (LSD) for YIELD

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	11990.22
Critical Value of t	2.44691
Least Significant Difference	189.46

Means with the same letter are not significantly different.

t Grouping	Mean	N	VARIETY
A	4890.25	4	B
B	4540.25	4	A
B	4532.25	4	C

在 90 年時 B 品種最優，而 A 和 C 品種則較差且無顯著差異

The SAS System

115

13:47 Saturday, April 27, 2002

The ANOVA Procedure

Class Level Information

Class	Levels	Values
YEAR	2	89 90
VARIETY	3	A B C
BLOCK	4	1 2 3 4

Number of observations 24

The SAS System

116

13:47 Saturday, April 27, 2002

The ANOVA Procedure

Dependent Variable: YIELD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	3332012.667	302910.242	6.68	0.0014
Error	12	543986.667	45332.222		
Corrected Total	23	3875999.333			

R-Square	Coeff Var	Root MSE	YIELD Mean
0.859653	4.781174	212.9136	4453.167

Source	DF	Anova SS	Mean Square	F Value	Pr > F
BLOCK(YEAR) <i>摺疊: (4-1)x2=</i>	6	279575.833	46595.972	1.03	0.4532
YEAR	1	970428.167	970428.167	21.41	0.0006
VARIETY	2	1322872.333	661436.167	14.59	0.0006
YEAR*VARIETY	2	759136.333	379568.167	8.37	0.0053

*品種間差異極顯著
交互效應存在*

Tests of Hypotheses Using the Anova MS for BLOCK(YEAR) as an Error Term

Source	DF	Anova SS	Mean Square	F Value	Pr > F
YEAR	1	970428.1667	970428.1667	20.83	0.0038

年度間差異極顯著 (F 測驗中以區集機差為分母)

The SAS System

117

13:47 Saturday, April 27, 2002

The ANOVA Procedure

t Tests (LSD) for YIELD

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	12
Error Mean Square	45332.22
Critical Value of t	2.17881
Least Significant Difference	231.95

Means with the same letter are not significantly different.

t Grouping	Mean	N	VARIETY
A	4665.8	8	B
A			
A	4567.8	8	A
B	4126.0	8	C

The SAS System 118

13:47 Saturday, April 27, 2002

The ANOVA Procedure
t Tests (LSD) for YIELD

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha 0.05
Error Degrees of Freedom 6
Error Mean Square 46595.97
Critical Value of t 2.44691
Least Significant Difference 215.63

Means with the same letter are not significantly different.

t Grouping	Mean	N	YEAR
A	4654.25	12	90
B	4252.08	12	89

The SAS System 119

13:47 Saturday, April 27, 2002

The ANOVA Procedure

Level of YEAR	Level of VARIETY	N	-----YIELD----- Mean	Std Dev
89	A	4	4595.25000	226.638295
89	B	4	4441.25000	337.397268
89	C	4	3719.75000	174.203664
90	A	4	4540.25000	176.979048
90	B	4	4890.25000	109.652101
90	C	4	4532.25000	188.750938

五、相關與回歸：

1. 研究人員欲從水稻之生育日數(GD)、穗數(SN)與稻穀產量(GY)三性狀中,瞭解其間之相關程度,該如何進行分析。
2. 以稻穀產量為依變數,生育日數為自變數之回歸關係。
以稻穀產量為依變數,穗數為自變數之回歸關係。
以稻穀產量為依變數,生育日數與穗數為自變數之複回歸關係。
以稻穀產量為依變數,生育日數為自變數之二次回歸關係。

	1	2	3	4	5	6	7	8	9	10	11	12
GD	120	128	126	120	134	131	129	129	100	110	115	102
SN	20	12	19	19	28	26	28	27	13	14	16	14
GY	7520	7160	7450	7000	8900	8560	9360	9100	5480	5600	6420	6100

SAS 程式語法:

```
DATA CORR;
  INFILE 'A:RICE.DAT';
INPUT R GD SN GY @@;
PROC CORR;
  VAR GD SN GY;
RUN;
DATA REG;
INFILE 'A:RICE.DAT';
INPUT R GD SN GY @@;
GD2=GD**2;
SN2=SN**2;
PROC REG;
  M1:MODEL GY=GD;
  M2:MODEL GY=SN;
  M3:MODEL GY=GD SN;
  M4:MODEL GY=GD GD2;
  M5:MODEL GY=SN SN2;
RUN;
```

RICE.DAT輸入格式：

```
1 120 20 7520 2 128 12 7160 3 126 19 7540 4 120 19 7000
5 134 28 8900 6 131 26 8560 7 129 28 9360 8 129 27 9100
9 100 13 5480 10 110 14 5600 11 115 16 6420 12 102 14 6100
```

相關與回歸 - 執行結果：

The SAS System

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The CORR Procedure

3 Variables: GD SN GY

Simple Statistics ← 簡單統計量

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
GD	12	120.33333	11.38846	1444	100.00000	134.00000
SN	12	19.66667	6.13979	236.00000	12.00000	28.00000
GY	12	7395	1354	88740	5480	9360

Pearson Correlation Coefficients, N = 12

Prob > |r| under H0: Rho=0

	GD	SN	GY
GD	1.00000	0.74411 0.0055	0.88658 ← 相關係數 0.0001 ← 顯著性機率值
SN	0.74411 0.0055	1.00000	0.92605 <.0001
GY	0.88658 0.0001	0.92605 <.0001	1.00000

The SAS System

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The REG Procedure

Model: M1 ← 回歸模式 1

Dependent Variable: GY ← 依變數名稱

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	15842604	15842604	36.73	0.0001
Error	10	4312696	431270		
Corrected Total	11	20155300			

Root MSE	656.71117	R-Square	0.7860	← 決定係數
Dependent Mean	7395.00000	Adj R-Sq	0.7646	
Coeff Var	8.88048			

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	-5285.54673	2100.75159	-2.52	0.0306
GD	1	105.37850	17.38654	6.06	0.0001

截距估計值 截距值的標準差
 隨變數名稱 回歸係數估計值 回歸係數值的標準差 <0.01, 回歸係數極顯著大於0

即 $YIELD = -5286 + 105^{} GD, R^2=0.79$**

The SAS System

7

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The REG Procedure

Model: M2

Dependent Variable: GY

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	17284523	17284523	60.21	<.0001
Error	10	2870777	287078		
Corrected Total	11	20155300			

Root MSE	535.79631	R-Square	0.8576
Dependent Mean	7395.00000	Adj R-Sq	0.8433
Coeff Var	7.24539		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	3379.77492	540.08618	6.26	<.0001
SN	1	204.16399	26.31178	7.76	<.0001

即 $YIELD = 3380 + 204^{} SN, R^2=0.86$**

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The REG Procedure

Model: M3

Dependent Variable: GY

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	19046041	9523020	77.27	<.0001
Error	9	1109259	123251		
Corrected Total	11	20155300			

Root MSE	351.07123	R-Square	0.9450
Dependent Mean	7395.00000	Adj R-Sq	0.9327
Coeff Var	4.74741		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	-1521.78390	1343.96754	-1.13	0.2868
GD	1	52.59809	13.91303	3.78	0.0043
SN	1	131.56678	25.80676	5.10	0.0006

$$\hat{YIELD} = -1522 + 53^{**}GD + 132^{**}SN, R^2=0.95$$

17:04 Saturday, April 27, 2002

The REG Procedure

Model: M4

Dependent Variable: GY

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	16605947	8302974	21.05	0.0004
Error	9	3549353	394373		
Corrected Total	11	20155300			

Root MSE	627.99086	R-Square	0.8239
Dependent Mean	7395.00000	Adj R-Sq	0.7848

Coeff Var 8.49210

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	29030	24747	1.17	0.2709
GD	1	-488.00454	426.83336	-1.14	0.2824
GD2	1	2.54048	1.82604	1.39	0.1976

>0.05, 回歸係數與0 無顯著差異

即 YIELD 隨 GD 的二次回歸式不存在

The SAS System

10

17:04 Saturday, April 27, 2002

The REG Procedure

Model: M5

Dependent Variable: GY

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	17488007	8744004	29.50	0.0001
Error	9	2667293	296366		
Corrected Total	11	20155300			

Root MSE 544.39494 R-Square 0.8677
Dependent Mean 7395.00000 Adj R-Sq 0.8383
Coeff Var 7.36166

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	5523.84788	2645.09576	2.09	0.0664
SN	1	-24.84580	277.66754	-0.09	0.9307
SN2	1	5.60076	6.75920	0.83	0.4288

即 YIELD 隨 SN 的二次回歸式不存在