**Modern College of Arts, Science and Commerce, Pune-05**

**Department of Statistics**

**M.Sc. II (Semester IV)**

**Date: Submission date:**

**Practical No. – 5(ii)**

**Title: Total & Partial Confounding in Factorial Experiments**

Q.1 The following table gives the plan and yield of a 24 field experiment on beans using two replicates divided into two blocks containing eight plots confounding one effect in each replication. Identify the confounded effects and analyze the data. The factors are Dung (D): none or 10 tons/ acre. Nitro chalk (N): none , or 0.4 cwt/acre, super phosphate(P): none, or 0.8 cwt/acre. Muriate of potash (K): none, or 1.0 cwt/acre.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Replicate I | | | | ReplicateII | | | |
| Block I | npkd | pd | nd | kd | npkd | np | nk | nd |
| 54 | 60 | 51 | 53 | 64 | 49 | 53 | 52 |
| npk | n | p | k | pkd | p | k | d |
| 48 | 52 | 55 | 65 | 54 | 49 | 60 | 52 |
| Block II | (1) | np | nk | pk | (1) | pk | kd | pd |
| 68 | 60 | 54 | 61 | 67 | 68 | 62 | 62 |
| d | npd | nkd | pkd | n | npk | nkd | npd |
| 63 | 58 | 51 | 65 | 57 | 53 | 44 | 66 |

Q.2 Coils were wound from each of two winding measures using either of the two wire stocks. Their outside diameters were measured at two positions on an optimal compactor. Four replications of the 23 experiment with factors machine (A), stock (B) and position (C) were run. Each replicate was divided into two blocks confounding one effect in each replication. The response (diameter of the wire) for each treatment combination is given in the table given below. Identify the confounded interactions and analyze the data.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Replicate I | | | | Replicate II | | | |
| Block I | | Block II | | Block I | | Block II | |
| ab | 2173 | b | 2300 | a | 2228 | ac | 3495 |
| (1) | 2249 | c | 3538 | abc | 3592 | (1) | 2094 |
| ac | 3532 | abc | 3524 | c | 3116 | bc | 2209 |
| bc | 2948 | a | 2319 | b | 2386 | ab | 2373 |
| Replicate III | | | | Replicate IV | | | |
| Block I | | Block II | | Block I | | Block II | |
| (1) | 2382 | c | 3528 | abc | 2996 | ab | 2393 |
| ab | 2240 | b | 2118 | a | 1934 | bc | 2814 |
| bc | 3595 | abc | 3350 | b | 2234 | ac | 3400 |
| ac | 2995 | a | 2272 | c | 2215 | (1) | 2297 |

Q.3 The following table gives the plan and the yield of manorial experiment involving three factors – N, P and K each at levels. Identify the confounded effects and analyze the data.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Block I | | | | Block II | | | |
| Replicate I | (1) | pk | nk | np | k | p | n | **npk** |
| 245 | 291 | 400 | 340 | 289 | 372 | 260 | 405 |
| Replicate II | (1) | k | npk | **np** | p | nk | pk | n |
| 326 | 259 | 340 | 282 | 366 | 400 | 333 | 378 |
| Replicate III | p | npk | (1) | **nk** | n | k | pk | np |
| 286 | 273 | 270 | 313 | 309 | 193 | 324 | 345 |
| Replicate IV | **pk** | (1) | npk | n | k | nk | np | p |
| 282 | 275 | 256 | 283 | 393 | 326 | 348 | 369 |

Q.4 The table gives the yield obtained from 25 factorial experiments. The five factors and their levels were as follows:

S: Spacing of rows at 10 inches or 24 inches

D: Dung at none or 10 inches or 24 inches

N: Nitro chalk at none or 0.4 cwt/acre

P: Super phosphate at none or 0.8 cwt/acre

K: Muriate of potash at none or 0.1 cwt/acre

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Block I |  | | | | | | |
| npk | 38.0 | s | 26.2 | snk | 50.5 | snp | 35.7 |
| sdp | 39.8 | **sdnpk** | 51.3 | n | 58.0 | k | 53.6 |
| dpk | 53.6 | dpn | 50.8 | sdk | 63.3 | sdn | 60.5 |
| spk | 64.3 | p | 46.7 | d | 64.8 | dnk | 63.7 |
| Block II |  | | | | | | |
| np | 36.3 | nd | 57.3 | dk | 41.3 | pk | 39.6 |
| dp | 76.7 | sp | 19.9 | sd | 44.7 | snpk | 37.9 |
| nk | 71.2 | (1) | 56.5 | ndpk | 67.0 | sdnp | 74.8 |
| sn | 23.3 | sk | 29.3 | sdpk | 66.3 | sdnk | 82.5 |

Identify the confounded interaction and analyze the data using higher order interactions as error.

**Answer-sheet 🡪**

**Que 1) Ans 🡪**



From the above graph it can be seen that the data follows normality .



It can be seen that the data points are randomly evenly distributed which concludes that variance in constant i.e homoscedasticity is observed. Therefore both the assumptions are satisfied.

**Full Factorial Design**

Factors: 4 Base Design: 4, 16 Resolution with blocks: V

Runs: 32 Replicates: 2

Blocks: 4 Center pts (total): 0

Block Generators: ABCD, replicates

Alias Structure

I

Blk = ABCD

A

B

C

D

AB

AC

AD

BC

BD

CD

ABC

ABD

ACD

BCD

**Design Table**

Run Block A B C D

1 1 + - - -

2 1 - + - -

3 1 - - + -

4 1 + + + -

5 1 - - - +

6 1 + + - +

7 1 + - + +

8 1 - + + +

9 2 - - - -

10 2 + + - -

11 2 + - + -

12 2 - + + -

13 2 + - - +

14 2 - + - +

15 2 - - + +

16 2 + + + +

17 3 + - - -

18 3 - + - -

19 3 - - + -

20 3 + + + -

21 3 - - - +

22 3 + + - +

23 3 + - + +

24 3 - + + +

25 4 - - - -

26 4 + + - -

27 4 + - + -

28 4 - + + -

29 4 + - - +

30 4 - + - +

31 4 - - + +

32 4 + + + +

**Analysis of Variance**

Source DF Adj SS Adj MS F-Value P-Value

Model 18 1114.12 61.896 3.68 0.010

Blocks 3 193.25 64.417 3.83 0.036

Linear 4 321.75 80.437 4.78 0.014

n 1 300.12 300.125 17.84 0.001

p 1 15.13 15.125 0.90 0.360

k 1 4.50 4.500 0.27 0.614

d 1 2.00 2.000 0.12 0.736

2-Way Interactions 6 453.75 75.625 4.49 0.011

n\*p 1 91.13 91.125 5.42 0.037

n\*k 1 40.50 40.500 2.41 0.145

n\*d 1 40.50 40.500 2.41 0.145

p\*k 1 24.50 24.500 1.46 0.249

p\*d 1 242.00 242.000 14.38 0.002

k\*d 1 15.13 15.125 0.90 0.360

3-Way Interactions 4 28.87 7.219 0.43 0.785

n\*p\*k 1 2.25 2.250 0.13 0.720

n\*p\*d 1 4.50 4.500 0.27 0.614

n\*k\*d 1 6.13 6.125 0.36 0.557

p\*k\*d 1 16.00 16.000 0.95 0.347

4-Way Interactions 1 66.13 66.125 3.93 0.069

n\*p\*k\*d 1 66.13 66.125 3.93 0.069

Error 13 218.75 16.827

Total 31 1332.87

**Model Summary**

S R-sq R-sq(adj) R-sq(pred)

4.10206 83.59% 60.86% 0.56%

Coded Coefficients

Term Effect Coef SE Coef T-Value P-Value VIF

Constant 57.187 0.725 78.86 0.000

Blocks

1 -2.81 1.62 -1.73 0.106 2.50

2 3.19 1.62 1.97 0.071 2.50

3 -4.06 1.62 -2.51 0.026 2.50

n -6.125 -3.062 0.725 -4.22 0.001 1.00

p 1.375 0.687 0.725 0.95 0.360 1.00

k -0.750 -0.375 0.725 -0.52 0.614 1.00

d -0.500 -0.250 0.725 -0.34 0.736 1.00

n\*p 3.375 1.687 0.725 2.33 0.037 1.00

n\*k -2.250 -1.125 0.725 -1.55 0.145 1.00

n\*d 2.250 1.125 0.725 1.55 0.145 1.00

p\*k 1.750 0.875 0.725 1.21 0.249 1.00

p\*d 5.500 2.750 0.725 3.79 0.002 1.00

k\*d -1.375 -0.688 0.725 -0.95 0.360 1.00

n\*p\*k 0.75 0.37 1.03 0.37 0.720 2.00

n\*p\*d 0.750 0.375 0.725 0.52 0.614 1.00

n\*k\*d 0.875 0.438 0.725 0.60 0.557 1.00

p\*k\*d 2.00 1.00 1.03 0.98 0.347 2.00

n\*p\*k\*d 2.875 1.438 0.725 1.98 0.069 1.00

**Regression Equation** in Uncoded Units

**Y = 57.187 - 3.062 n + 0.687 p - 0.375 k - 0.250 d + 1.687 n\*p - 1.125 n\*k + 1.125 n\*d + 0.875 p\*k + 2.750 p\*d - 0.688 k\*d + 0.37 n\*p\*k + 0.375 n\*p\*d + 0.438 n\*k\*d + 1.00 p\*k\*d + 1.438 n\*p\*k\*d**

Equation averaged over blocks.

Alias Structure

Factor Name

A n

B p

C k

D d

Aliases

I

Block 1

As highlighted above,

p-value < alpha = 0.05 for the main effect “N” (Nitro chalk) the interaction effects “NP” , “PD” and the block 3 which concludes that they are significantly contributing is estimating the response variable that is Yield of beans (Y)

Block 2

Block 3

A

B

C

D

AB

AC

AD

BC

BD

CD

ABC

ABD

ACD

BCD

ABCD

Fits and Diagnostics for Unusual Observations

Obs Y Fit Resid Std Resid

16 54.00 59.62 -5.62 -2.15 R

32 64.00 58.37 5.63 2.15 R



From pareto graph, the main effect “N” (Nitro chalk) the interaction effects “NP” , “PD” and the block 3 which concludes that they are significantly contributing is estimating the response variable that is Yield of beans (Y)

**Que 2) Ans 🡪**





From the above graph it can be seen that the data follows normality . It can be seen that the data points are randomly evenly distributed which concludes that variance in constant i.e homoscedasticity is observed. Therefore both the assumptions are satisfied.

**Full Factorial Design**

Factors: 3 Base Design: 3, 8 Resolution with blocks: IV

Runs: 32 Replicates: 4

Blocks: 8 Center pts (total): 0

Block Generators: ABC, replicates

Alias Structure

I

Blk = ABC

A

B

C

AB

AC

BC

**Design Table**

Run Block A B C

1 1 - - -

2 1 + + -

3 1 + - +

4 1 - + +

5 2 + - -

6 2 - + -

7 2 - - +

8 2 + + +

9 3 - - -

10 3 + + -

11 3 + - +

12 3 - + +

13 4 + - -

14 4 - + -

15 4 - - +

16 4 + + +

17 5 - - -

18 5 + + -

19 5 + - +

20 5 - + +

21 6 + - -

22 6 - + -

23 6 - - +

24 6 + + +

25 7 - - -

26 7 + + -

27 7 + - +

28 7 - + +

29 8 + - -

30 8 - + -

31 8 - - +

32 8 + + +

**Factorial Regression: y versus Blocks, a, b, c**

**The following terms are totally confounded with other terms and were removed:**

**a\*b\*c**

**Analysis of Variance**

Source DF Adj SS Adj MS F-Value P-Value

Model 13 8495210 653478 6.63 0.000

Blocks 7 962356 137479 1.39 0.267

Linear 3 7143552 2381184 24.15 0.000

a 1 243777 243777 2.47 0.133

b 1 3806 3806 0.04 0.846

c 1 6895970 6895970 69.95 0.000

2-Way Interactions 3 389302 129767 1.32 0.300

a\*b 1 51280 51280 0.52 0.480

a\*c 1 290513 290513 2.95 0.103

b\*c 1 47509 47509 0.48 0.496

Error 18 1774550 98586

Total 31 10269760

**Model Summary**

S R-sq R-sq(adj) R-sq(pred)

313.984 82.72% 70.24% 45.39%

Coded Coefficients

Term Effect Coef SE Coef T-Value P-Value VIF

Constant 2713.7 55.5 48.89 0.000

Blocks

1 12 147 0.08 0.937 1.75

2 207 147 1.41 0.177 1.75

3 -171 147 -1.16 0.260 1.75

4 117 147 0.80 0.437 1.75

5 89 147 0.61 0.551 1.75

6 103 147 0.70 0.491 1.75

7 12 147 0.08 0.934 1.75

a 174.6 87.3 55.5 1.57 0.133 1.00

b -21.8 -10.9 55.5 -0.20 0.846 1.00

c 928.4 464.2 55.5 8.36 0.000 1.00

a\*b 80.1 40.0 55.5 0.72 0.480 1.00

a\*c 190.6 95.3 55.5 1.72 0.103 1.00

b\*c -77.1 -38.5 55.5 -0.69 0.496 1.00

**Regression Equation** in Uncoded Units

**y = 2713.7 + 87.3 a - 10.9 b + 464.2 c + 40.0 a\*b + 95.3 a\*c - 38.5 b\*c**

Equation averaged over blocks.

Alias Structure

Factor Name

A a

B b

C c

Aliases

I

Block 1 - ABC

Block 2 + ABC

Block 3 - ABC

Block 4 + ABC

Block 5 - ABC

Block 6 + ABC

Block 7 - ABC

A

B

C

AB

AC

BC

Fits and Diagnostics for Unusual Observations

Obs y Fit Resid Std Resid

12 2209 2735 -526 -2.23 R

20 3595 2995 600 2.55 R

31 2215 2716 -501 -2.13 R

As highlighted above, p-value < alpha = 0.05 for the main effect “C” (Position) is significantly contributing is estimating the response variable that is Diameter of wire (Y).



From pareto graph,

the main effect “C” (Position) is significantly contributing is estimating the response variable that is Diameter of wire (Y).

**Que 3) Ans 🡪**



From the above graph it can be seen that the data follows normality.



It can be seen that the data points are randomly evenly distributed which concludes that variance in constant i.e homoscedasticity is observed. Therefore both the assumptions are satisfied.

**Full Factorial Design**

Factors: 3 Base Design: 3, 8 Resolution with blocks: IV

Runs: 32 Replicates: 4

Blocks: 8 Center pts (total): 0

Block Generators: ABC, replicates

Alias Structure

I

Blk = ABC

A

B

C

AB

AC

BC

**Design Table**

Run Block A B C

1 1 - - -

2 1 + + -

3 1 + - +

4 1 - + +

5 2 + - -

6 2 - + -

7 2 - - +

8 2 + + +

9 3 - - -

10 3 + + -

11 3 + - +

12 3 - + +

13 4 + - -

14 4 - + -

15 4 - - +

16 4 + + +

17 5 - - -

18 5 + + -

19 5 + - +

20 5 - + +

21 6 + - -

22 6 - + -

23 6 - - +

24 6 + + +

25 7 - - -

26 7 + + -

27 7 + - +

28 7 - + +

29 8 + - -

30 8 - + -

31 8 - - +

32 8 + + +

**Factorial Regression: Y versus Blocks, n, p, k**

**Analysis of Variance**

Source DF Adj SS Adj MS F-Value P-Value

Model 14 41965.6 2997.54 1.18 0.371

Blocks 7 26510.1 3787.16 1.48 0.238

Linear 3 6252.3 2084.11 0.82 0.502

n 1 4632.0 4632.03 1.82 0.195

p 1 504.0 504.03 0.20 0.662

k 1 1116.3 1116.28 0.44 0.517

2-Way Interactions 3 1647.8 549.25 0.22 0.884

n\*p 1 12.0 12.04 0.00 0.946

n\*k 1 1290.7 1290.67 0.51 0.487

p\*k 1 345.0 345.04 0.14 0.718

3-Way Interactions 1 590.0 590.04 0.23 0.637

n\*p\*k 1 590.0 590.04 0.23 0.637

Error 17 43358.1 2550.48

Total 31 85323.7

**Model Summary**

S R-sq R-sq(adj) R-sq(pred)

50.5023 49.18% 7.34% 0.00%

Coded Coefficients

Term Effect Coef SE Coef T-Value P-Value VIF

Constant 316.59 8.93 35.46 0.000

Blocks

1 -2.6 25.8 -0.10 0.922 2.08

2 19.9 25.8 0.77 0.451 2.08

3 -14.1 25.8 -0.55 0.590 2.08

4 51.9 25.8 2.02 0.060 2.08

5 -38.4 25.8 -1.49 0.154 2.08

6 -16.5 25.8 -0.64 0.530 2.08

7 -38.8 25.8 -1.51 0.151 2.08

n 24.06 12.03 8.93 1.35 0.195 1.00

p 7.94 3.97 8.93 0.44 0.662 1.00

k 11.81 5.91 8.93 0.66 0.517 1.00

n\*p -1.4 -0.7 10.3 -0.07 0.946 1.33

n\*k 14.7 7.3 10.3 0.71 0.487 1.33

p\*k -7.6 -3.8 10.3 -0.37 0.718 1.33

n\*p\*k -9.9 -5.0 10.3 -0.48 0.637 1.33

**Regression Equation** in Uncoded Units

**Y = 316.59 + 12.03 n + 3.97 p + 5.91 k - 0.7 n\*p + 7.3 n\*k - 3.8 p\*k - 5.0 n\*p\*k**

Equation averaged over blocks.

Alias Structure

Factor Name

A n

B p

C k

Aliases

I

Block 1

Block 2

Block 3

Block 4

Block 5

Block 6

Block 7

A

B

C

AB

AC

BC

ABC

Fits and Diagnostics for Unusual Observations

Obs Y Fit Resid Std Resid

23 193.0 280.8 -87.8 -2.38 R

As highlighted in the above table,

There is no p-value which is less than alpha=0.05 which concludes that there is no significant effect.

****

From the pareto graph ,

We can conclude that there is no significant effect.

**Que 4) Ans 🡪**

**Full Factorial Design**

Factors: 5 Base Design: 5, 32 Resolution with blocks: VI

Runs: 32 Replicates: 1

Blocks: 2 Center pts (total): 0

Block Generators: ABCDE

Alias Structure

I

Blk = ABCDE

A

B

C

D

E

AB

AC

AD

AE

BC

BD

BE

CD

CE

DE

ABC

ABD

ABE

ACD

ACE

ADE

BCD

BCE

BDE

CDE

ABCD

ABCE

ABDE

ACDE

BCDE

Design Table

Run Block A B C D E

1 1 - - - - -

2 1 + + - - -

3 1 + - + - -

4 1 - + + - -

5 1 + - - + -

6 1 - + - + -

7 1 - - + + -

8 1 + + + + -

9 1 + - - - +

10 1 - + - - +

11 1 - - + - +

12 1 + + + - +

13 1 - - - + +

14 1 + + - + +

15 1 + - + + +

16 1 - + + + +

17 2 + - - - -

18 2 - + - - -

19 2 - - + - -

20 2 + + + - -

21 2 - - - + -

22 2 + + - + -

23 2 + - + + -

24 2 - + + + -

25 2 - - - - +

26 2 + + - - +

27 2 + - + - +

28 2 - + + - +

29 2 + - - + +

30 2 - + - + +

31 2 - - + + +

32 2 + + + + +

**Factorial Regression: y versus Blocks, s, d, n, p, k**

**The following terms are totally confounded with other terms and were removed:**

**s\*d\*n\*p\*k**

**Analysis of Variance**

Source DF Adj SS Adj MS F-Value P-Value

Model 31 8033.59 259.15 \* \*

Blocks 1 0.45 0.45 \* \*

Linear 5 3201.24 640.25 \* \*

s 1 343.22 343.22 \* \*

d 1 2301.81 2301.81 \* \*

n 1 162.90 162.90 \* \*

p 1 72.00 72.00 \* \*

k 1 321.31 321.31 \* \*

2-Way Interactions 10 1935.98 193.60 \* \*

s\*d 1 456.02 456.02 \* \*

s\*n 1 88.45 88.45 \* \*

s\*p 1 141.96 141.96 \* \*

s\*k 1 609.00 609.00 \* \*

d\*n 1 56.71 56.71 \* \*

d\*p 1 85.81 85.81 \* \*

d\*k 1 120.90 120.90 \* \*

n\*p 1 327.68 327.68 \* \*

n\*k 1 27.01 27.01 \* \*

p\*k 1 22.44 22.44 \* \*

3-Way Interactions 10 2037.06 203.71 \* \*

s\*d\*n 1 84.50 84.50 \* \*

s\*d\*p 1 675.28 675.28 \* \*

s\*d\*k 1 0.61 0.61 \* \*

s\*n\*p 1 6.66 6.66 \* \*

s\*n\*k 1 788.05 788.05 \* \*

s\*p\*k 1 7.80 7.80 \* \*

d\*n\*p 1 9.68 9.68 \* \*

d\*n\*k 1 7.80 7.80 \* \*

d\*p\*k 1 24.50 24.50 \* \*

n\*p\*k 1 432.18 432.18 \* \*

4-Way Interactions 5 858.85 171.77 \* \*

s\*d\*n\*p 1 3.25 3.25 \* \*

s\*d\*n\*k 1 165.62 165.62 \* \*

s\*d\*p\*k 1 199.00 199.00 \* \*

s\*n\*p\*k 1 463.60 463.60 \* \*

d\*n\*p\*k 1 27.38 27.38 \* \*

Error 0 \* \*

Total 31 8033.59

**Model Summary**

S R-sq R-sq(adj) R-sq(pred)

\* 100.00% \* \*

Coded Coefficients

SE

Term Effect Coef Coef T-Value P-Value VIF

Constant 51.42 \* \* \*

Blocks

1 0.1187 \* \* \* 1.00

s -6.550 -3.275 \* \* \* 1.00

d 16.962 8.481 \* \* \* 1.00

n 4.512 2.256 \* \* \* 1.00

p -3.000 -1.500 \* \* \* 1.00

k 6.337 3.169 \* \* \* 1.00

s\*d 7.550 3.775 \* \* \* 1.00

s\*n 3.325 1.663 \* \* \* 1.00

s\*p 4.213 2.106 \* \* \* 1.00

s\*k 8.725 4.362 \* \* \* 1.00

d\*n 2.662 1.331 \* \* \* 1.00

d\*p 3.275 1.638 \* \* \* 1.00

d\*k -3.888 -1.944 \* \* \* 1.00

n\*p -6.400 -3.200 \* \* \* 1.00

n\*k 1.8375 0.9188 \* \* \* 1.00

p\*k -1.6750 -0.8375 \* \* \* 1.00

s\*d\*n 3.250 1.625 \* \* \* 1.00

s\*d\*p -9.188 -4.594 \* \* \* 1.00

s\*d\*k -0.2750 -0.1375 \* \* \* 1.00

s\*n\*p 0.9125 0.4563 \* \* \* 1.00

s\*n\*k -9.925 -4.963 \* \* \* 1.00

s\*p\*k -0.9875 -0.4937 \* \* \* 1.00

d\*n\*p 1.1000 0.5500 \* \* \* 1.00

d\*n\*k 0.9875 0.4937 \* \* \* 1.00

d\*p\*k -1.7500 -0.8750 \* \* \* 1.00

n\*p\*k -7.350 -3.675 \* \* \* 1.00

s\*d\*n\*p 0.6375 0.3187 \* \* \* 1.00

s\*d\*n\*k -4.550 -2.275 \* \* \* 1.00

s\*d\*p\*k -4.987 -2.494 \* \* \* 1.00

s\*n\*p\*k -7.613 -3.806 \* \* \* 1.00

d\*n\*p\*k 1.8500 0.9250 \* \* \* 1.00

**Regression Equation** in Uncoded Units

y = 51.42 - 3.275 s + 8.481 d + 2.256 n - 1.500 p + 3.169 k + 3.775 s\*d + 1.663 s\*n

+ 2.106 s\*p + 4.362 s\*k + 1.331 d\*n + 1.638 d\*p - 1.944 d\*k - 3.200 n\*p + 0.9188 n\*k

- 0.8375 p\*k + 1.625 s\*d\*n - 4.594 s\*d\*p - 0.1375 s\*d\*k + 0.4563 s\*n\*p - 4.963 s\*n\*k

- 0.4937 s\*p\*k + 0.5500 d\*n\*p + 0.4937 d\*n\*k - 0.8750 d\*p\*k - 3.675 n\*p\*k

+ 0.3187 s\*d\*n\*p - 2.275 s\*d\*n\*k - 2.494 s\*d\*p\*k - 3.806 s\*n\*p\*k + 0.9250 d\*n\*p\*k

Equation averaged over blocks.

Alias Structure

Factor Name

A s

B d

C n

D p

E k

Aliases

I

Block 1 - ABCDE

A

B

C

D

E

AB

AC

AD

AE

BC

BD

BE

CD

CE

DE

ABC

ABD

ABE

ACD

ACE

ADE

BCD

BCE

BDE

CDE

ABCD

ABCE

ABDE

ACDE

BCDE



From the graph we can observe that effects d, snp, sdp, sk are only significantly contributing in the model whereas others are negligible so we form a model my using there effects only .

**Factorial Regression: y versus Blocks, s, d, n, p, k**

**Analysis of Variance**

Source DF Adj SS Adj MS F-Value P-Value

Model 14 6073.27 433.80 3.76 0.006

Blocks 1 0.45 0.45 0.00 0.951

Linear 5 3201.24 640.25 5.55 0.003

s 1 343.22 343.22 2.98 0.103

d 1 2301.81 2301.81 19.96 0.000

n 1 162.90 162.90 1.41 0.251

p 1 72.00 72.00 0.62 0.440

k 1 321.31 321.31 2.79 0.113

2-Way Interactions 6 1408.25 234.71 2.04 0.116

s\*d 1 456.02 456.02 3.95 0.063

s\*n 1 88.45 88.45 0.77 0.393

s\*p 1 141.96 141.96 1.23 0.283

s\*k 1 609.00 609.00 5.28 0.035

d\*p 1 85.81 85.81 0.74 0.400

n\*k 1 27.01 27.01 0.23 0.635

3-Way Interactions 2 1463.33 731.66 6.35 0.009

s\*d\*p 1 675.28 675.28 5.86 0.027

s\*n\*k 1 788.04 788.04 6.83 0.018

Error 17 1960.32 115.31

Total 31 8033.59

**Model Summary**

S R-sq R-sq(adj) R-sq(pred)

10.7384 75.60% 55.50% 13.54%

Coded Coefficients

Term Effect Coef SE Coef T-Value P-Value VIF

Constant 51.42 1.90 27.09 0.000

Blocks

1 0.12 1.90 0.06 0.951 1.00

s -6.55 -3.28 1.90 -1.73 0.103 1.00

d 16.96 8.48 1.90 4.47 0.000 1.00

n 4.51 2.26 1.90 1.19 0.251 1.00

p -3.00 -1.50 1.90 -0.79 0.440 1.00

k 6.34 3.17 1.90 1.67 0.113 1.00

s\*d 7.55 3.77 1.90 1.99 0.063 1.00

s\*n 3.33 1.66 1.90 0.88 0.393 1.00

s\*p 4.21 2.11 1.90 1.11 0.283 1.00

s\*k 8.72 4.36 1.90 2.30 0.035 1.00

d\*p 3.27 1.64 1.90 0.86 0.400 1.00

n\*k 1.84 0.92 1.90 0.48 0.635 1.00

s\*d\*p -9.19 -4.59 1.90 -2.42 0.027 1.00

s\*n\*k -9.92 -4.96 1.90 -2.61 0.018 1.00

**Regression Equation** in Uncoded Units

**y = 51.42 - 3.28 s + 8.48 d + 2.26 n - 1.50 p + 3.17 k + 3.77 s\*d + 1.66 s\*n + 2.11 s\*p + 4.36 s\*k + 1.64 d\*p + 0.92 n\*k - 4.59 s\*d\*p - 4.96 s\*n\*k**

Equation averaged over blocks.

Alias Structure

Factor Name

A s

B d

C n

D p

E k

As highlighted above,

p-value < alpha = 0.05 for the main effect “D” (Dung at none or 10 inches or 24 inches) the interaction effects “SK” , “SDP” and “SNK” which concludes that they are significantly contributing is estimating the response variable Y

Aliases

I

Block 1 - ABCDE

A

B

C

D

E

AB

AC

AD

AE

BD

CE

ABD

ACE

Fits and Diagnostics for Unusual Observations

Std

Obs y Fit Resid Resid

8 74.80 58.60 16.20 2.07 R

29 64.30 46.99 17.31 2.21 R



From the above graph it can be seen that the data follows normality.



It can be seen that the data points are randomly evenly distributed which concludes that variance in constant i.e homoscedasticity is observed. Therefore both the assumptions are satisfied.



From the pareto graph ,

the main effect “D” (Dung at none or 10 inches or 24 inches) the interaction effects “SK” , “SDP” and “SNK” which concludes that they are significantly contributing is estimating the response variable Y .