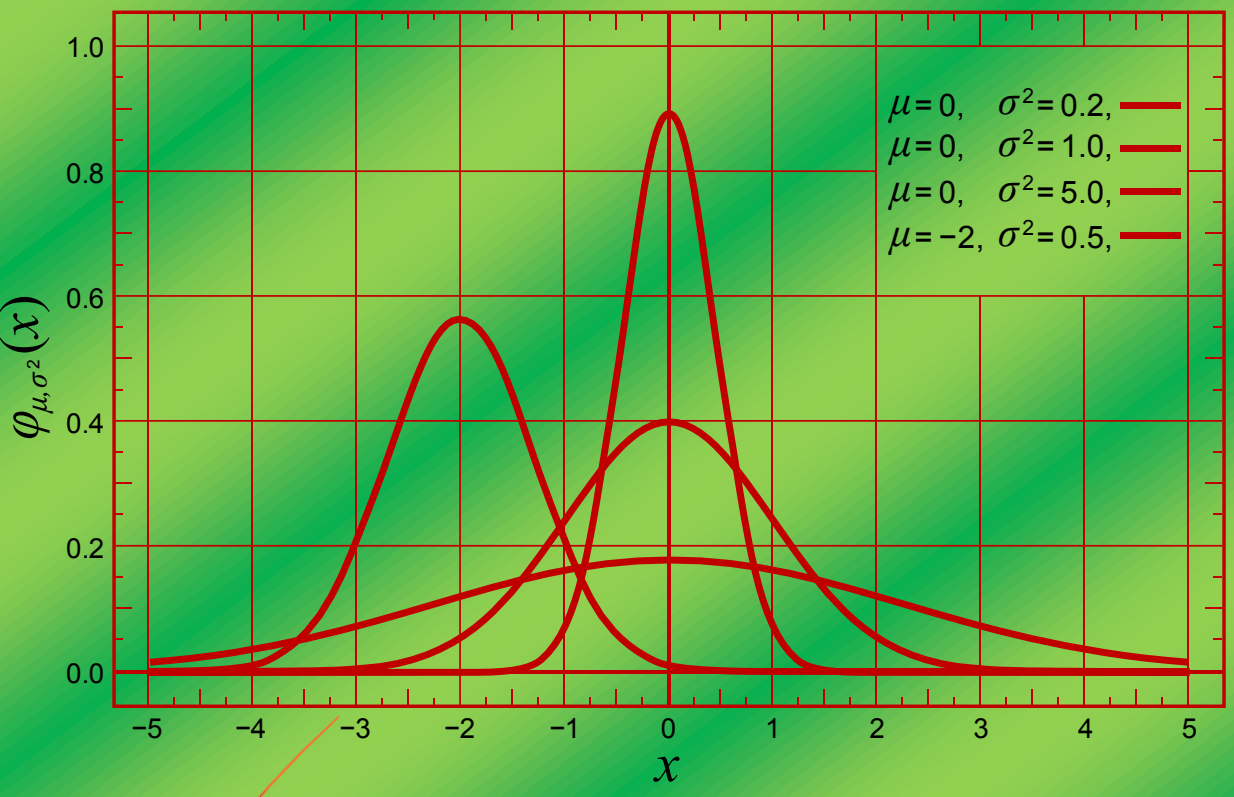
SPSS Practical Manual on Latin Square Design (LSD)



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Example:

The following table gives the yields in pound per plot, of four varieties A, B, C and D of wheat after being applied to each of 4 plots, tested in a Latin Square Design

D 33	C 33	A 33	B 35
B 38	A 33	C 37	D 32
A 33	B 36	D 35	C 32
C 32	D 32	B 37	A 29

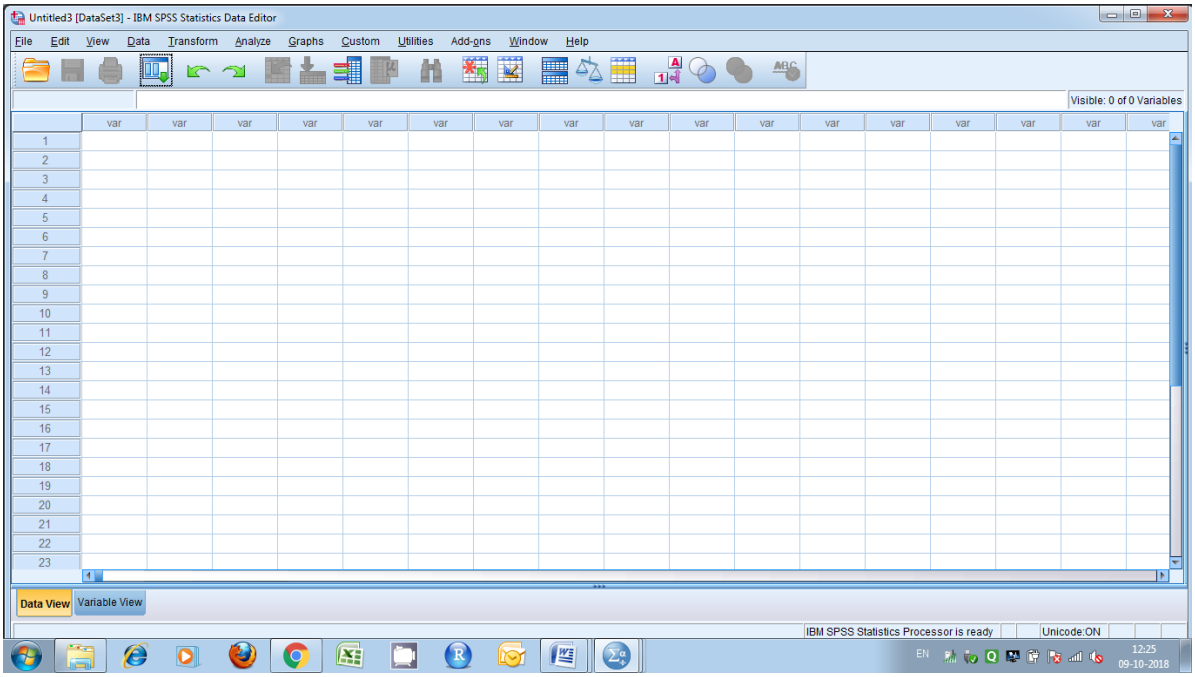
Arragment of data for Analysis

row	col	Treat	yield
1	1	4	33
1	2	3	33
1	3	1	33
1	4	2	35
2	1	2	38
2	2	1	33
2	3	3	37
2	4	4	32
3	1	1	33
3	2	2	36
3	3	4	35
3	4	3	32
4	1	3	32
4	2	4	32
4	3	2	37
4	4	1	29

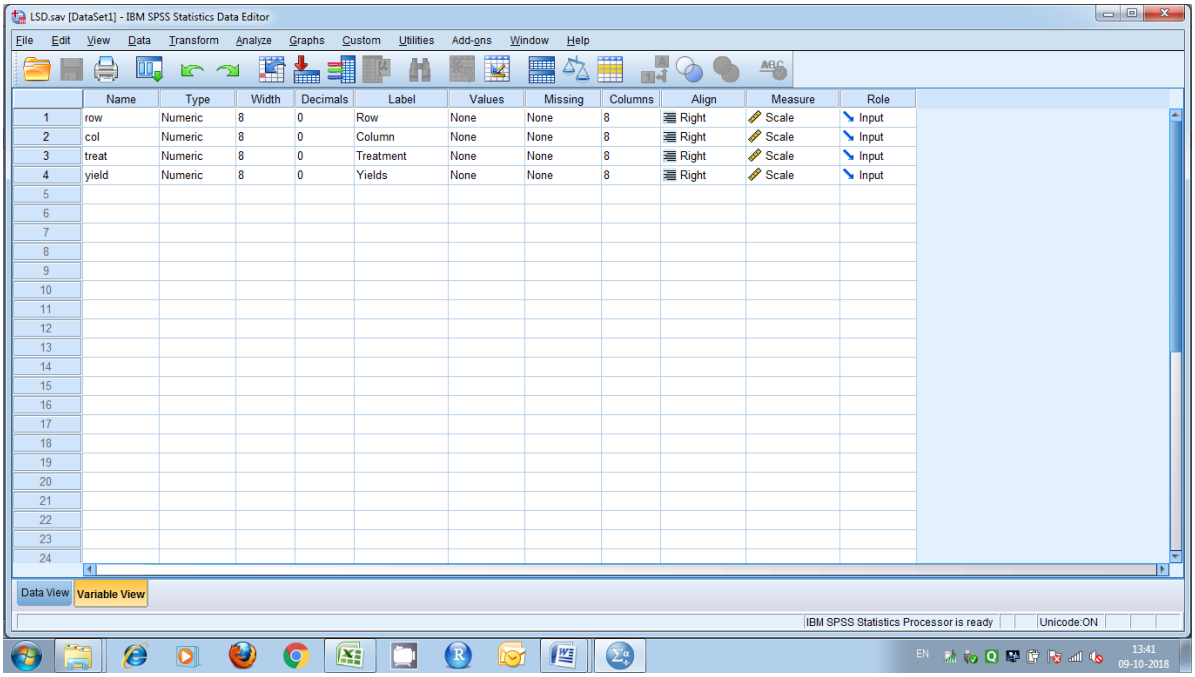
SPSS commands for analysis

The input data file can be created as shown below:

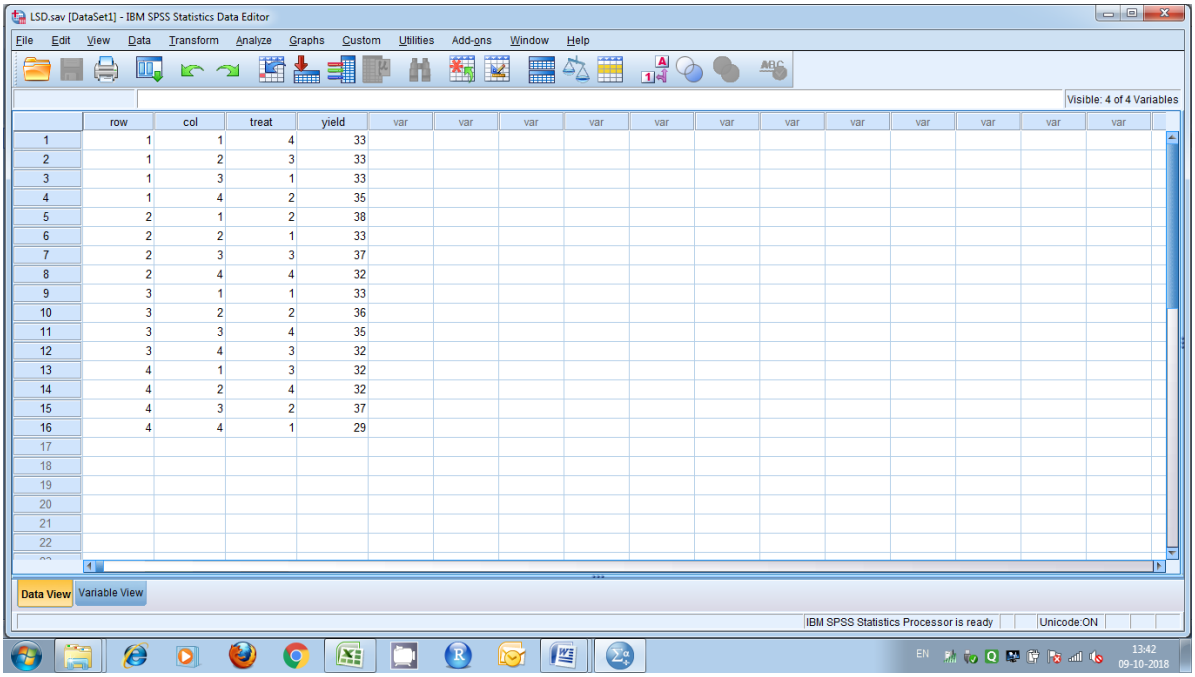
Step 1: File → New → Data →



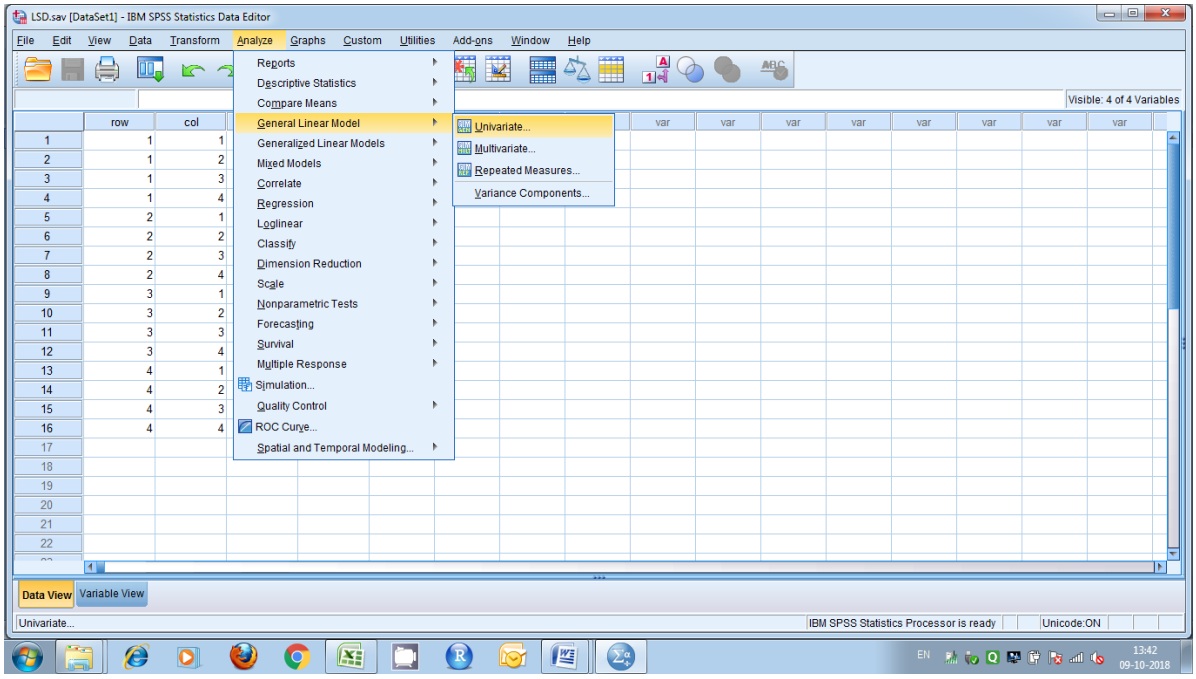
Step 2: Variable view → Name (row, col, treat, yield) →



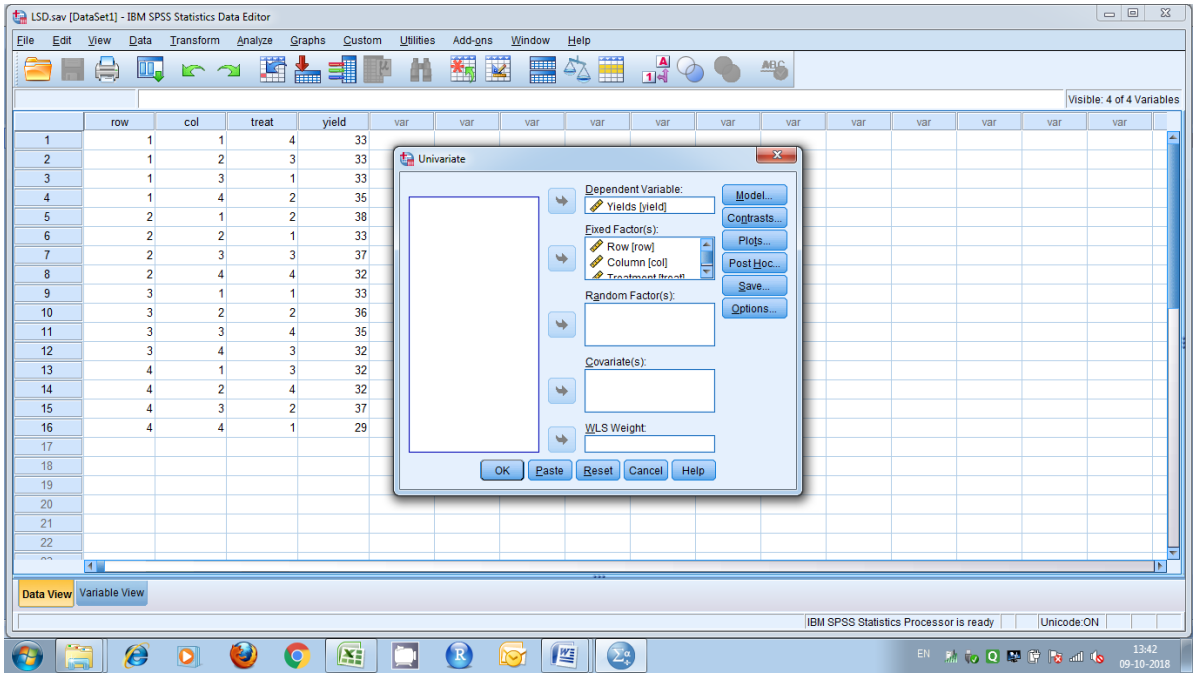
Step 3: Data view → Enter data → File → Save (with file name)



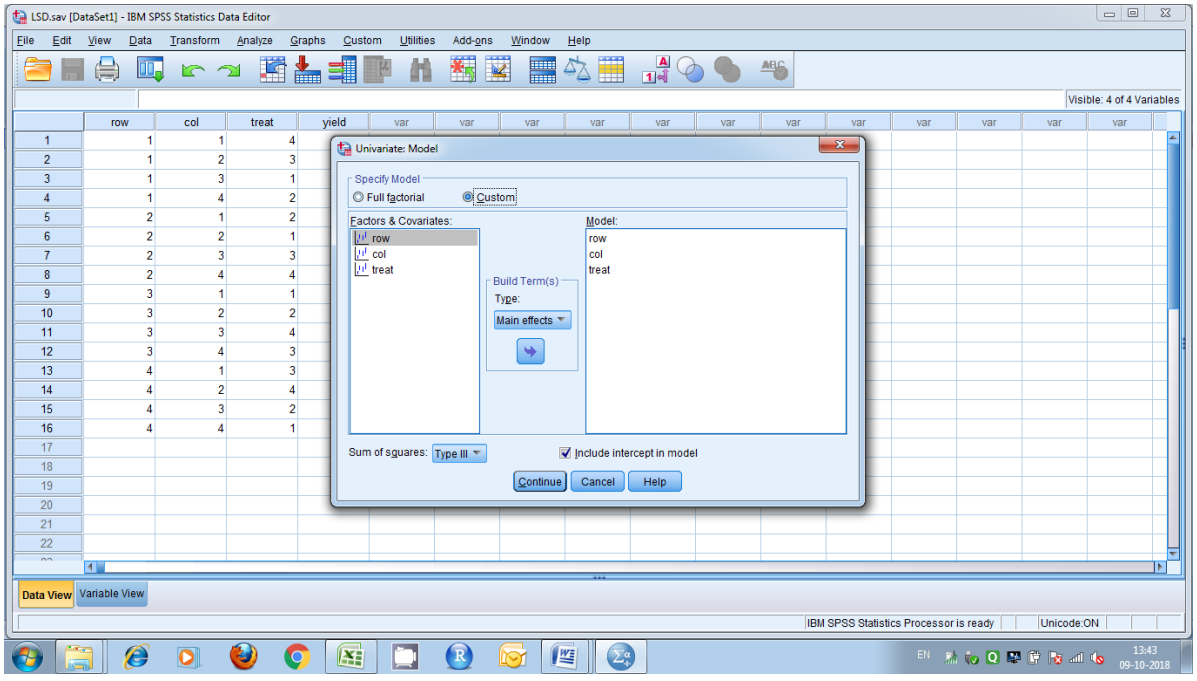
Step 4: Analyze → General linear model → Univariate →



Step 5: Dependent variable (yield) → Fixed factors (row, col, treat)



Step 6: Model → Custom → Main effects → Build terms (row, col, treat) → Sum of Squares (Type III) → Continue



Mathematical model:

$$y_{ijk} = \mu + a_i + \beta_j + \gamma_k + \varepsilon_{ijk}; \qquad (i = j = k = 1, 2, \ldots, n)$$

$$\textbf{Yield} = \mu + \textbf{Treatment} + \textbf{Row} + \textbf{Column} + \varepsilon_{ij}$$

where y_{ijk} = Response of the j^{th} replication, i^{th} treatment and k^{th} column

μ = general mean effect

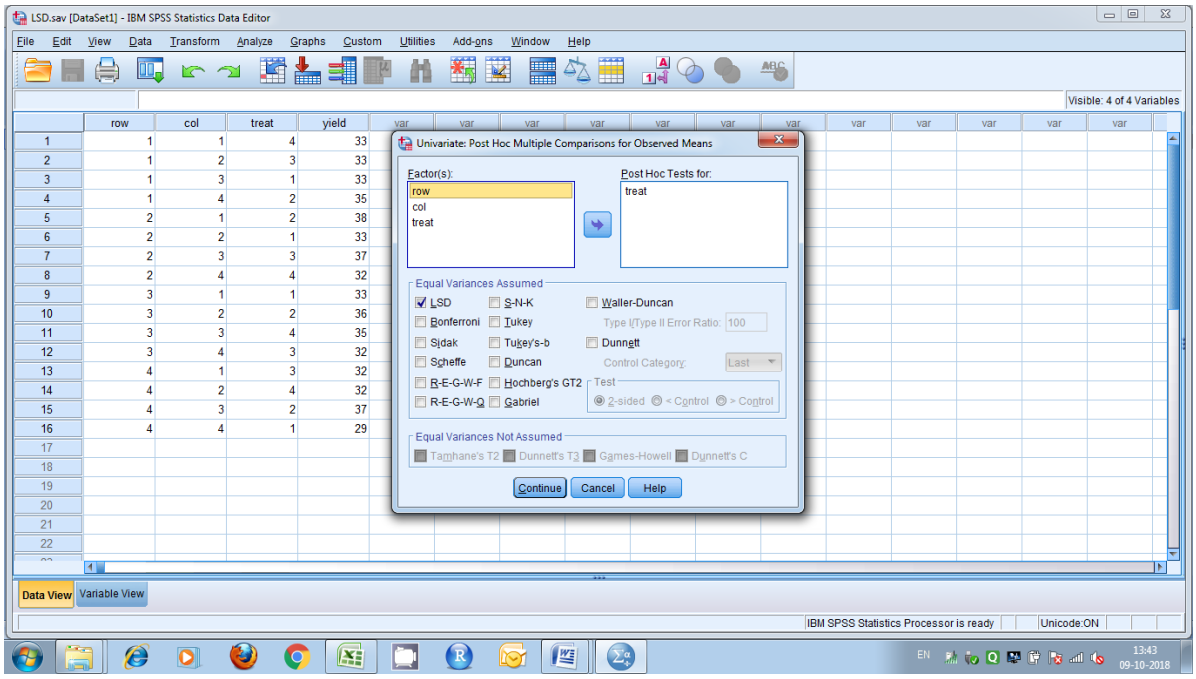
a_i = i^{th} treatment effect

β_j = j^{th} row effect

γ_k = k^{th} column effect

ε_{ijk} = error effect with mean = 0 and variance = σ^2 [N(0, σ^2)]

Step 7: Post Hoc → Post Hoc Tests for (treat) → LSD → OK



ANOVA –Treatments

Tests of Between-Subjects Effects

Dependent Variable: Yields

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
row	13.000	3	4.333	13.000	.005
col	25.000	3	8.333	25.000	.001
treat	45.000	3	15.000	45.000**	.000
Error	2.000	6	.333		
Corrected Total	85.000	15			

a. R Squared = .976 (Adjusted R Squared = .941)

** Significant at 1% level of significance

Yields

Treatment	Mean	N	Std. Deviation
1	32.00	4	2.000
2	36.50	4	1.291
3	33.50	4	2.380
4	33.00	4	1.414
Total	33.75	16	2.380

POSTHOC TESTS – Treatments

Multiple Comparisons

Dependent Variable: Yields

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-4.50*	.408	.000	-5.50	-3.50
	3	-1.50*	.408	.010	-2.50	-.50
	4	-1.00*	.408	.050	-2.00	.00
2	1	4.50*	.408	.000	3.50	5.50
	3	3.00*	.408	.000	2.00	4.00
	4	3.50*	.408	.000	2.50	4.50
3	1	1.50*	.408	.010	.50	2.50
	2	-3.00*	.408	.000	-4.00	-2.00
	4	.50	.408	.267	-.50	1.50
4	1	1.00*	.408	.050	.00	2.00
	2	-3.50*	.408	.000	-4.50	-2.50
	3	-.50	.408	.267	-1.50	.50

Do Yourself

An Experiment on cotton was conducted to study the effect of foliar application of urea in combination with insecticidal sprays in the cotton yield. Five treatments were tried in a 5×5 Latin Square Design. The layout and yield are given below.

T2 4.9	T4 6.4	T5 3.3	T1 9.5	T3 11.8
T3 9.3	T1 4.0	T2 6.2	T5 5.1	T4 5.4
T4 7.0	T3 15.4	T1 6.5	T2 6.0	T5 4.6
T5 5.3	T2 7.6	T3 13.2	T4 8.6	T1 4.9
T1 9.3	T5 6.3	T4 11.8	T3 15.9	T2 7.6

Analyze the data and state your conclusions.

Reference Books:

1. A Hand Book of Agricultural Statistics, S. R. S. Chandel, Achal Prakashan Mandir, Kanpur.
2. A Text book of Agricultural Statistics, R. Rangaswamy, New Age International (P) Limited, publishers.
3. Biometrical Methods in Quantitative Genetic Analysis, R.K. Singh and B. D. Chaudhary, Kalyani Publishers.
4. Design Resources Server: www.iasri.res.in
5. E-Manual Winter School IASRI.
6. Fundamentals of Mathematical Statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons Educational Publications.
7. Fundamentals Applied Statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons Educational Publications.
8. Programmed Statistics, B.L. Agarwal, New Age International (P) Limited, publishers.
9. Probability and Statistical Inference Theory and Practice, D. Bhattacharya and S. Roy Chowdhury, U. N. Dhur & Sons.
10. Statistics Theory and Practice, D. Bhattacharya and S. Roy Chowdhury, U. N. Dhur & Sons.
11. Statistical Methods, K.P. Dhamu and K. Ramamoorthy, AGROBIOS (INDIA).
12. Statistics for Agricultural Sciences, G. Nageswara Rao, Second Edition, BS Publications, Hyderabad.