



SNS COLLEGE OF TECHNOLOGY
(AN AUTONOMOUS INSTITUTION)
COIMBATORE - 35



UNIT - 2 DESIGN OF EXPERIMENTS
LATIN SQUARE DESIGN

2) The following is a latin square of a design when 4 varieties of seeds are being tested. Set up the analysis of variance table and state your conclusion. You may carry out suitable change of origin and scale.

A(105)	B(95)	C(125)	D(115)
C(115)	D(125)	A(105)	B(105)
D(115)	C(95)	B(105)	A(115)
B(95)	A(135)	D(95)	C(115)

Solution:

Null Hypothesis H_0 : There is no significant difference between the seeds

Alternative Hypothesis H_1 : There is a significant difference between the seeds.



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By shifting the origin to '115' by subtracting '115' from each entries, $N=16, T=-80, CF = \frac{T^2}{N} = \frac{80^2}{16} = 400$

$Y \backslash X$	X_1	X_2	X_3	X_4	Total	X_1^2	X_2^2	X_3^2	X_4^2
Y_1	-10	-20	10	0	-20	100	400	100	0
Y_2	0	10	-10	-10	-10	0	100	100	100
Y_3	0	-20	-10	0	-30	0	400	100	0
Y_4	-20	20	-20	0	-20	400	400	400	0
Total	-30	-20	-30	-10	-80	500	1300	700	100

$$TSS = \sum X_1^2 + \sum X_2^2 + \sum X_3^2 + \sum X_4^2 - CF$$

$$= 500 + 1300 + 700 + 100 - 400$$

$$= 2200$$

$$SSC = \frac{(\sum X_1)^2}{4} + \frac{(\sum X_2)^2}{4} + \frac{(\sum X_3)^2}{4} + \frac{(\sum X_4)^2}{4} - CF$$

$$= \frac{(-30)^2}{4} + \frac{(-20)^2}{4} + \frac{(-30)^2}{4} + \frac{(-10)^2}{4} - 400$$

$$= 500 - 400 = 100$$

$$SSR = \frac{(\sum Y_1)^2}{4} + \frac{(\sum Y_2)^2}{4} + \frac{(\sum Y_3)^2}{4} + \frac{(\sum Y_4)^2}{4} - CF$$

$$= \frac{(-20)^2}{4} + \frac{(-10)^2}{4} + \frac{(-30)^2}{4} + \frac{(-20)^2}{4} - 400$$

$$= 450 - 400$$

$$SSR = 50$$



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To find SST:

					Total
A	-10	20	-10	0	$\Sigma x_1 = 0$
B	-20	-20	-10	-10	$\Sigma x_2 = -60$
C	-10	-20	10	0	$\Sigma x_3 = -20$
D	0	10	-20	0	$\Sigma x_4 = -10$

$$SST = \frac{(\Sigma x_1)^2}{4} + \frac{(\Sigma x_2)^2}{4} + \frac{(\Sigma x_3)^2}{4} + \frac{(\Sigma x_4)^2}{4} - CF$$

$$= \frac{(0)^2}{4} + \frac{(-60)^2}{4} + \frac{(-20)^2}{4} + \frac{(-10)^2}{4} - 400$$

$$= 1025 - 400$$

$$= 625$$

$$SSE = TSS - SSC - SSR - SST$$

$$= 2200 - 100 - 50 - 625$$

$$= 1425$$

Source of Variation	Degrees of freedom	Sum of Squares	Mean Sum of Squares	F-Ratio	F_α
Columns	$C-1 = 4-1 = 3$	$SSC = 100$	$MSC = \frac{100}{3} = 33.33$	$F_c = \frac{MSE}{MSC} = \frac{237.5}{33.33} = 7.13$	$F_\alpha(3,6) = 4.72$
Rows	$r-1 = 3$	$SSR = 50$	$MSR = \frac{50}{3} = 16.67$	$F_r = \frac{MSE}{MSR} = \frac{237.5}{16.67} = 14.25$	$F_\alpha(6,3) = 9.94$
Treatments	$n-1 = 3$	$SST = 625$	$MST = \frac{625}{3} = 208.3$	$F_t = \frac{MSE}{MST} = \frac{237.5}{208.3} = 1.14$	
Error	$(n-1)(r-2) = 3 \times 2 = 6$	$SSE = 1425$	$MSE = \frac{1425}{6} = 237.5$		



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Conclusion:-

$$\therefore F_R = 14.25 > 9.14 = F_{\alpha}(6,3)$$

$$R_C = 7.13 < 9.14 = F_{\alpha}(6,3)$$

$$F_T = 1.14 < 9.14 = F_{\alpha}(6,3)$$

There is a significant diff b/w the rows. (Reject H_0)
and There is no significant diff b/w the columns
& seeds (Accept H_0).