

Randomized Block Design (RBD)

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Objective:

To Analyze Randomized Block Design (RBD)

The yields of 4 varieties (A, B, C and D) of a crop in lbs. along with the plan of the experiment are given below. Analyze the data and draw your conclusion.

	R ₁	R ₂	R ₃	Total	Mean
A	25	21	21	T _A = 67	$\bar{Y}_A = 22$
B	25	28	24	T _B = 77	$\bar{Y}_B = 26$
C	24	24	16	T _C = 64	$\bar{Y}_C = 21$
D	20	17	16	T _D = 53	$\bar{Y}_D = 18$
Total	94	90	77	GT = 261	

Solution

Linear model

$$Y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij}; \quad (i=1,2, \dots, k; \quad j=1,2, \dots, r)$$

where Y_{ij} = Response of the j^{th} replication and i^{th} treatment

μ = General mean effect

α_i = i^{th} treatment effect

β_j = j^{th} Block effect

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

Hypothesis

H_0 : All varieties of wheat have equal effect on yield ($\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4$)

H_1 : All α_i 's are not equal

Here No. of Treatments (k) =4, No. of Replications (r) = 3,

No. of Observations (n) = $k \times r = 12$

Correction Factor (C.F.)

$$= \frac{GT^2}{n} = \frac{(261)^2}{12} = 5676.75$$

Total Sum of Square (TSS)

$$= \sum_{i=1}^k \sum_{j=1}^r y_{ij}^2 - C.F.$$

$$= (25^2 + 21^2 + \dots + 17^2 + 16^2) - 5676.75 = 168.25$$

Sum of square due to treatment (SST)

$$= \frac{(T_A^2 + T_B^2 + T_C^2 + T_D^2)}{r} - C.F.$$

$$= \frac{(67^2 + 77^2 + 64^2 + 53^2)}{3} - 5676.75$$

$$= 97.58$$

S.S. due to replication (SSR)

$$= \frac{(R_1^2 + R_2^2 + R_3^2)}{k} - C.F.$$

$$= \frac{(94^2 + 90^2 + 77^2)}{4} - 5676.75$$

$$= 39.50$$

S.S. due to error (SSE) = T.S.S. – (SST+ SSR)

$$= 168.25 - (97.58 + 39.50) = 31.17$$

ANOVA table

Source of variation	Degree of Freedom	Sum of Squares	Mean Sum of Squares	F _{cal}	F _(3,6)	
					5%	1%
Treatments	k-1=3	97.58	32.53	6.26**	4.76	9.78
Replications	r-1=2	39.50	19.75			
Error	(k-1)(r-1)=6	31.17	5.19			
Total	(kr-1)=11					

Since $F_{cal}=6.26 > F_{tab}=9.78$, Therefore null hypothesis H_0 at (1%) level of significance with degree of freedom (3, 6) will be rejected. Hence there is significant difference between varieties.

To test the varieties of wheat (pair wise) arranges means in descending order

$$\bar{Y}_B=26, \bar{Y}_A=22, \bar{Y}_C=21, \bar{Y}_D=18$$

$$SE(d) = \sqrt{EMS \left(\frac{1}{r_i} + \frac{1}{r_j} \right)} = \sqrt{Ve \left(\frac{1}{r_i} + \frac{1}{r_j} \right)} = \sqrt{5.20 \left(\frac{1}{3} + \frac{1}{3} \right)} = 1.86$$

Critical Difference (C.D.)

$$= SE(d) \times t_{\text{error d.f.}} (5\%)$$

$$= 1.86 \times t_6 (5\%)$$

$$= 1.86 \times 2.45 = 4.56$$

Varities	Difference of varities means	Compare with CD
B-A	4	
B-C	5	Significant
B-D	8	Significant
A-C	1	
A-D	4	
C-A	3	

$$\bar{y} = \frac{GT}{n} = \frac{261}{12} = 21.75$$

$$CV = \frac{\sqrt{MSE}}{\bar{y}} \times 100 = \frac{\sqrt{5.20}}{21.75} \times 100 = 10.48\%$$

Conclusion - Varity B gives significantly higher yield than all other varieties; but the remaining varieties are all on par.

Exercise:

The yields of 6 varieties of a crop in lbs. along with the plan of the experiment are given below. The number of blocks is 5, plot of size is 1/20 acre and the varieties have been represented by A, B, C, D and E. Analyze the data and state your conclusions.

Block 1	B 12	E 26	D 10	C 15	A 26	F 62
Block 2	E 23	C 16	F 56	A 30	D 20	B 10
Block 3	A 28	B 9	E 35	F 64	D 23	C 14
Block 4	F 75	D 20	E 30	C 14	B 7	A 23
Block 5	D 17	F 70	A 20	C 12	B 9	E 28