Lecture.21

Split plot design – layout – ANOVA Table

Split-plot Design

In field experiments certain factors may require larger plots than for others. For example, experiments on irrigation, tillage, etc requires larger areas. On the other hand experiments on fertilizers, etc may not require larger areas. To accommodate factors which require different sizes of experimental plots in the same experiment, split plot design has been evolved.

In this design, larger plots are taken for the factor which requires larger plots. Next each of the larger plots is split into smaller plots to accommodate the other factor. The different treatments are allotted at random to their respective plots. Such arrangement is called split plot design.

In split plot design the larger plots are called main plots and smaller plots within the larger plots are called as sub plots. The factor levels allotted to the main plots are main plot treatments and the factor levels allotted to sub plots are called as sub plot treatments.

Layout and analysis of variance table

First the main plot treatment and sub plot treatment are usually decided based on the needed precision. The factor for which greater precision is required is assigned to the sub plots.

The replication is then divided into number of main plots equivalent to main plot treatments. Each main plot is divided into subplots depending on the number of sub plot treatments. The main plot treatments are allocated at random to the main plots as in the case of RBD. Within each main plot the sub plot treatments are allocated at random as in the case of RBD. Thus randomization is done in two stages. The same procedure is followed for all the replications independently.

The analysis of variance will have two parts, which correspond to the main plots and sub-plots. For the main plot analysis, replication X main plot treatments table is

formed. From this two-way table sum of squares for replication, main plot treatments and error (a) are computed. For the analysis of sub-plot treatments, main plot X sub-plot treatments table is formed. From this table the sums of squares for sub-plot treatments and interaction between main plot and sub-plot treatments are computed. Error (b) sum of squares is found out by residual method. The analysis of variance table for a split plot design with *m* main plot treatments and *s* sub-plot treatments is given below.

Analysis of variance for split plot with factor A with m levels in main plots and factor B with s levels in sub-plots will be as follows:

Sources of Variation	d.f.	SS	MS	F
Replication	r-1	RSS	RMS	RMS/EMS (a)
A	m-1	ASS	AMS	AMS/EMS (a)
Error (a)	(r-1) (m-1)	ESS (a)	EMS (a)	
B	s-1	BSS	BMS	BMS/EMS (b)
AB	(m-1) (s-1)	ABSS	ABMS	ABMS/EMS (b)
Error (b)	m(r-1) (s-1)	ESS (b)	EMS (b)	
Total	rms – 1	TSS		

Analysis

Arrange the results as follows

Treatment Combination	**Replication**				**Total**
	R1	**R2**	**R3**	**…**	
A0B0	a0b0	a0b0	a0b0	…	T00
A0B1	a0b1	a0b1	a0b1	…	T01
A0B2	a0b2	a0b2	a0b2	…	T02
Sub Total	A01	A02	A03	…	T0
A1B0	a1b0	a1b0	a1b0	…	T10
A1B1	a1b1	a1b1	a1b1	…	T11
A1B2	a1b2	a1b2	a1b2	…	T12
Sub Total	A11	A12	A13	…	T1
. . .	. . .	. . .	. . .	. . .	. . .
Total	R1	R2	R3	…	G.T

$$\text{Compute CF} = \frac{(G\ T)^2}{r \times m \times s}$$

TSS=[$(a0b0)^2 + (a0b1)^2 + (a0b2)^2 + \ldots$]-CF

Form A x R Table and calculate RSS, ASS and Error (a) SS

Treatment	Replication				Total
	R1	R2	R3	…	
A0	A01	A02	A03	…	T0
A1	A11	A12	A13	…	T1
A2	A21	A22	A23	…	T2
. . .	. . .	. . .	. . .	. . .	. . .
Total	R1	R2	R3	…	GT

$$\text{RSS} = \left(\frac{R1^2 + R2^2 + R3^2 + \ldots}{m.\ s} \right) - CF$$

$$\text{ASS} = \left(\frac{T0^2 + T1^2 + T3^2 + \ldots}{r.\ s} \right) - CF$$

$$\text{A x R table SS} = \left(\frac{A01^2 + A02^2 + A03^2 + \ldots}{b} \right) - CF$$

Error (a) SS= A x R TSS-RASS-ASS.

Form A xB Table and calculate BSS, Ax B SSS and Error (b) SS

Treatment	Replication				Total
	B0	B1	B2	…	
A0	T00	T01	T02	…	T0
A1	T10	T11	T12	…	T1
A2	T20	T21	T22	…	T2
. . .	. . .	. . .	. . .	. . .	. . .
Total	C0	C1	C2	…	GT

$$\text{BSS} = \left(\frac{C0^2 + C1^2 + C2^2 + \ldots}{r.\ m} \right) - CF$$

$$\text{A x B table SS} = \left(\frac{T0^2 + T1^2 + T3^2 + \ldots}{r} \right) - CF$$

ABSS= A x B Table SS – ASS- ABSS

Error (b) SS= Table SS-ASS-BSS-ABSS –Error (a) SS.

Then complete the ANOVA table.

Questions

1. To accommodate factors which require different sizes of experimental plots in the same experiment_____ design has been evolved

a) Split plot b) CRD c) RBD d)LSD

Ans: Split plot

2. The number of error terms in a split plot design is

a) One b**)** two c) three d) none of these

Ans: two

3. The plot size for the subplot treatment will be small when compared to the plot size of the main plot treatments.

Ans: True

4. The precision for the sub plot treatments is more when compared to the main plot treatments.

Ans: True

5. The plot sizes for the main plot treatment and subplot treatment are not same.

Ans: True

6. The plot size for subplot and interaction are same in split plot design.

Ans: True

7. When will you adopt split plot design?

8. What is error (a) in a split plot design?

9. Furnish the skeleton ANOVA table with 3 replications, 4 main plot treatments and 3 subplot treatments.

10. Furnish the layout of a split plot design.