

Faculty Science

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B Sc III -Paper I (Plant Resource Utilization, Palynology, Plant Pathology and Biostatistics)

Unit- IV Topic- Experimental Designs

The research design is a conceptual structure within which research is conducted. It consists of blueprint for the collection, measurement and analysis of data.

A scientifically planned method is called experiment. Various objects of comparison are known as treatment. The group of material to which treatment is applied in single trial of experiment is known as experimental unit. It may be a plot, patient in hospital etc.

Principles of experimental designs

There are three basic principles of experimental designs replication, randomization and local control. All these principles help in reducing the experimental error and make the experiment more efficient.

1. Replication- Repetition of treatments under investigation is known as replication. So that experiment should be repeated more than once. By doing so the statistical accuracy of experiments is increased.

2. Randomization- Allocation of treatments of different plots by random process is known as randomization of treatments. It provides protection against the effect of extraneous features. It gives equal chance to all treatments for being allotted to a more fertile plot and to a less fertile plot.

3. Local control- Grouping of homogeneous experimental units is known as local control. According to this principle we first divide the field into several homogeneous units known as blocks and then each such block is divided into parts equal to the number of treatments. Then the treatments are randomly assigned to these parts of a block so that we can eliminate the variability due to the extraneous factor from experimental error.

Informal experimental designs

A. Before and after without control design

B. After only with control design

C. Before and after with control design

Formal experimental designs

1. Completely Randomized Design (CRD)
2. Randomized Block Design (RBD)
3. Latin Square Design (LSD)

1. Completely Randomized Design- It is an experiment where the treatments are assigned at random. Every experiment unit has same chance of receiving a particular treatment. This design is usually used only in laboratory experiments, where environmental factors are relatively easy to control. This design involves only two principles replication and randomization. e.g. If there are four treatments A, B, C, D with three replication 1, 2, 3.

A1	B1	C2	A1
D2	A3	B1	C2
B3	D2	C1	A2

Advantages of CRD- i). It is flexible so that any number of treatments and replications can be used. There may be different number of replications for different treatments.

ii). The analysis is easy and simple, if number of replications are unequal for each treatment.

iii). Analysis remains simple when data are missing.

iv). It provides maximum number of degrees of freedom for error for a given number of experimental units and treatments.

Disadvantages- i). The main disadvantage of CRD is that the principle of local control is not used so that experimental error is high.

ii). It is not suited for large number of treatments because relatively large number of experimental materials is needed which increases the variations.

2. Randomized Block Design- It is an improvement over the CRD. In this design all three principles of experimental designs are used. In this subject are first divided into groups known as blocks such that within each group subjects are relatively homogeneous. The number of subjects in a given block would be equal to the number of treatments and one subject in each block would be randomly assigned to each treatment. e.g. Suppose four different forms of a standardised test in biostatistics were given to each of five students (selected one from each of the five I.Q. blocks) and following are the scores which they obtained. If each student separately randomized the order in which he or she took the four tests (by using random numbers or some similar devices), we refer to the design of this experiment as a RBD. The purpose of this randomization is to take care of such possible extraneous factors or perhaps the experience gained from repeatedly taking the test.

	Very low I.Q.	Low I.Q.	Average I.Q.	High I.Q.	Very High I.Q.
	Student A	Student B	Student C	Student D	Student E
Form 1	83	66	58	73	75
Form 2	91	67	55	70	82
Form 3	87	72	52	69	85
Form 4	94	76	62	65	71

Advantages of RBD- i) All three replication, randomization and local control are used it is more reliable and valid than CRD.

ii) Analysis can be done if some values are missing.

iii) The precision is more as compared to CRD.

iv) Amount of information of obtained in RBD is more as compared to CRD.

v) It is flexible. Any number of replications can be included in RBD.

vi) Statistical analysis is simple and easy.

Disadvantages- i) When the number of treatments increases the block size increases so that error increases.

ii) The number of replications for each treatment is same.

3. Latin Square Design- This is an experimental design very frequently used in agricultural research. In this design treatments are so allocated among plots that no treatment occurs more than once in any row or any one column. for example five types of fertilizers A, B, C, D and E and two blocking factors varying soil fertility I, II, III, IV, V and the varying seeds X_1, X_2, X_3, X_4, X_5 .

Soil Fertility Levels

Seed differences	I	II	III	IV	V
X_1	A	B	C	D	E
X_2	B	C	D	E	A
X_3	C	D	E	A	B
X_4	D	E	A	B	C
X_5	E	A	B	C	D

Advantages of LSD- i) LSD is more efficient than the RBD or CRD.
ii) Because of the double grouping the experimental error is small.
iii) When missing values are present, missing plot technique can be used and analysed.

Disadvantages- i) It is not as flexible as RBD or CRD as number of treatments is limited to the number of rows and columns.

ii) LSD is not suitable for treatments less than 5, the degree of freedom is very small thus the results are not reliable.

iii) If number of treatments increases the size of Latin square increases and this causes disturbance in heterogeneity.

iv) In practice we use LSD from 5 x 5 to 10 x 10.

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