Plant Archives Vol. 19 No. 2, 2019 pp. 2121-2125 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

STATISTICAL ANALYSIS PROCEDURE OF RANDOMISED BLOCK DESIGN (RBD) FOR HORTICULTURAL DATA ON POTATO PLANT

V. Sekhar[1], K. Umakrishna[1], V. Srinivasa Rao[2] and T. Thomson[3]

[1]Department of Statistics, College of Horticulture, Venkataramannagudem, Dr. YSR Horticultural University, West Godavari, (Andhra Pradesh) India.

[2]Department of Statistics, Agricultural College, Bapatla, Acharya NG Ranga Agricultural University, Guntur, (Andhra Pradesh) India.

[3]College of Horticulture, Venkataramannagudem, Dr. YSR Horticultural University, West Godavari, (Andhra Pradesh) India.

Abstract

This paper was attempted to find out best treatment among 10 treatments by using Randomised Block Design analysis. RBD is most suitable for Agricultural field experiments when fertility gradient is in one direction. In this design, the treatments are assigned to the experimental plots in a random manner in blocks. This article considers the application, advantages and disadvantages and statistical analysis of randomized block designs.

Key words : RBD, ANOVA, CD.

Introduction

In RBD, the entire experimental material is divided into number of homogeneous blocks. Each and every treatment should appear only once in each block.;

RBD follows all the basic principles of Experimental Designs

1. Replication
2. Randomisation
3. Local Control

RBD follows ANOVA-II way classification

Assumptions of ANOVA

1. Independence of cases – this is an assumption of the model that simplifies the statistical analysis.
2. Normality – the distributions of the residuals are normal.
3. Equality (or homogeneity) of variances, called homoscedasticity.

Advantages of RBD

1. This design has complete flexibility, *i.e.*, any number of replications can be included in this design
2. The amount of information got in RBD is more as compared CRD.
3. The statistical analysis is simple and easy. Even some observations are missing for certain treatments, the data can be analysed by the missing plot technique.

Disadvantages of RBD

1. When the number of treatments is increased, the block size will increase.
2. If the block size is large maintaining homogeneity is difficult and hence when more number of treatments is present this design may not be suitable.

Materials and Method

A varietal trial is conducted on Potato (*Solanum tuberossum*) with 10 varieties and each variety is replicated 3 times at College of Horticulture, Venkataramannagudem. Yield per plant in gms are as follows. Analyse the data and draw your conclusion

***Author for correspondence :** E-mail : sekhar30mscstat@gmail.com

Null Hypothesis for Treatments

H_0 : There is no significant difference among mean

Treatments	R-I	R-II	R-III
T_1	138.20	153.40	170.40
T_2	173.80	187.00	208.20
T_3	218.40	216.20	247.20
T_4	250.20	273.40	247.00
T_5	163.40	206.60	157.20
T_6	207.80	173.00	237.40
T_7	268.20	180.60	226.40
T_8	193.20	178.20	126.60
T_9	236.80	182.60	166.20
T_{10}	266.80	184.60	185.40

Sol:

Treatments	Replications			Treatment Totals	Treatment Means
	R_1	R_2	R_3		
T_1	138.20	153.40	170.40	T_1=462	$\alpha_1 = \frac{T_1}{r} = \frac{462}{3} = 154$
T_2	173.80	187.00	208.20	T_2=569	$\alpha_2 = \frac{T_2}{r} = \frac{569}{3} = 189.67$
T_3	218.40	216.20	247.20	T_3=681.80	$\alpha_3 = \frac{T_3}{r} = \frac{681.8}{3} = 227.27$
T_4	250.20	273.40	247.00	T_4=770.60	$\alpha_4 = \frac{T_4}{r} = \frac{770.60}{3} = 256.87$
T_5	163.40	206.60	157.20	T_5=527.20	$\alpha_5 = \frac{T_5}{r} = \frac{527.20}{3} = 175.73$
T^6	207.80	173.00	237.40	T_6=618.20	$\alpha_6 = \frac{T_6}{r} = \frac{618.20}{3} = 206.07$
T_7	268.20	180.60	226.40	T_7=675.20	$\alpha_7 = \frac{T_7}{r} = \frac{675.20}{3} = 225.07$
T_8	193.20	178.20	126.60	T_8=498	$\alpha_8 = \frac{T_8}{r} = \frac{498}{3} = 166$
T_9	236.80	182.60	166.20	T_9=585.60	$\alpha_9 = \frac{T_9}{r} = \frac{585.60}{3} = 195.20$
T_{10}	266.80	184.60	185.40	T_{10}=636.80	$\alpha_{10} = \frac{T_{10}}{r} = \frac{636.80}{3} = 212.27$
Replication Totals	R_1=2116.80	R_2=1935.60	R_3=1972.00	GT=6024.40	
Replication	$\beta_1 = \frac{R_1}{k} =$	$\beta_2 = \frac{R_2}{k} =$	$\beta_3 = \frac{R_3}{k} =$		
Means	$\frac{2116.8}{10} = 211$	$\frac{1935.60}{10} = 193.56$	$\frac{1972}{10} = 197.21$		

The mathematica model for RBD is $x_{ij} = \mu + \alpha_i + \beta_j + \epsilon_{ij}$.

of varieties

$$H_0 : \alpha_1 = \alpha_2 = ... = \alpha_{10}$$

Alternative Hypothesis for Treatments

H_1 : There is significant difference among mean of varieties

$$H_1 : \alpha_1 \neq \alpha_2 \neq .... \neq \alpha_{10}$$

Null Hypothesis for Blocks

H_0 : There is no significant difference among mean of Replications / Blocks

$$H_0 : \beta_1 = \beta_2 = \beta_3$$

Alternative Hypothesis for Treatments

H_1 : There is significant difference among mean of Replications / Blocks

$$H_1 : \beta_1 \neq \beta_2 \neq \beta_3$$

k is no. Of varieties = 10

r is no. Of replications = 3

$$GM = \frac{GT}{kr} = \frac{6024.40}{10*3} = \frac{6024.40}{30} = 200.8133$$

$$CF = \frac{GT^2}{kr} = \frac{6024.40^2}{10*3} = \frac{6024.40*6024.40}{30}$$

$$= \frac{36293395}{30} = 1209780$$

$$\text{Total } SS = \sum_{i=1}^{k}\sum_{j=1}^{r} x_{ij}^2 - CF = (x_{1,1}^2 + x_{1,2}^2 + ... + x_{10,3}^2) - CF$$

$$= (138.2^2 + 153.4^2 + ... + 185.4^2) - 1209780$$

$$= 1255244 - 1209780 = 45464.39$$

$$Trt\ SS = \frac{T_1^2 + T_2^2 + ... + T_k^2}{r} - CF$$

$$= \frac{462^2 + 569^2 + ... + 636.8^2}{3} - 1209780$$

$$= \frac{3708332}{3} - 1209780 = 1236111 - 1209780 = 26330.93$$

$$\text{Rep/Block } SS = \frac{R_1^2 + R_2^2 + ... + R_r^2}{k} - CF$$

Prepare the following ANOVA Table

Sources of Variation	Degrees of freedom	Sum of Squares	Mean Sum of Squares	F-Cal	F-tab
Treatments	k-110-1=9	Trt SS= 26330.93	$Trt\ MSS = \frac{Trt.SS}{k-1}$ $= \frac{26330.93}{9} = 2925.659$	$\frac{Trt.MSS}{\text{Error } MSS}$ $\frac{2925.659}{960.8862} = 3.0448*$	$F_{k-1,(k-1)(r-1)}$ $F_{9,18} = 2.4563$ at 5% $F_{9,18} = 3.5971$ at 1%
Replications	r-13-1=2	Rep SS=1837.5147	$\text{Rep } SS\ MSS = \frac{\text{Rep}.SS}{r-1}$ $= \frac{1837.5147}{2} = 918.7573$	$\frac{\text{Rept}.MSS}{\text{Error } MSS}$ $\frac{918.7573}{960.8862} = 0.9562$	$F_{r-1,(k-1)(r-1)}$ $F_{2,18} = 3.5546$ at 5% $F_{2,18} = 6.0129$ at 1%
Error	(k-1)(r-1)(10-1) (3-1)=18	Error SS= 17295.95	$\text{Error } MSS = \frac{Error.SS}{(k-1)-(r-1)}$ $= \frac{17295.95}{18} = 960.8862$	-------	-------
Total	kr-110*3-1=29	Total SS= 45464.39	--------	-------	-------

$$=\frac{2116.80^2+1935.6^2+1972^2}{10}-1209780$$

$$=\frac{12116174}{10}-1209780$$

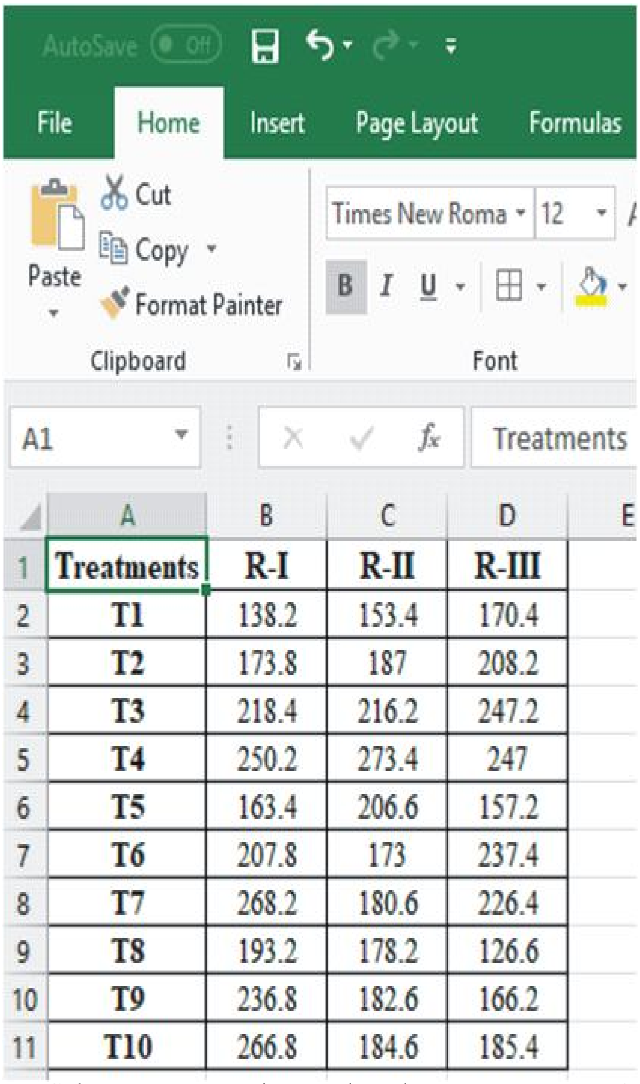
$$=1211617.4-1209780=1837.5147$$

Error SS = Total SS – Trt SS – Rep SS

$$=45464.39-26330.93-1837.5147=17295.95$$

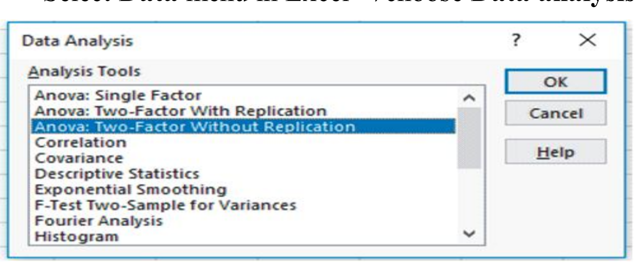
Analysis procedure of RBD in MS-Excel

In MS-Excel sheet, enter data as below picture

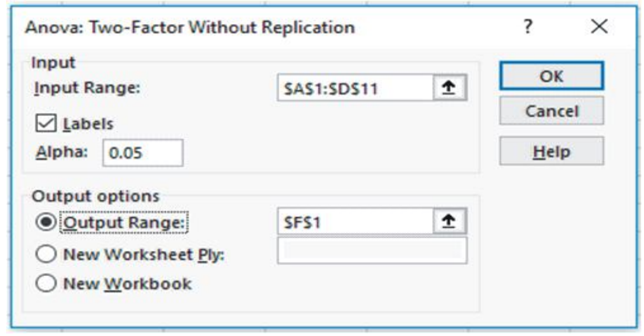


	A	B	C	D
1	Treatments	R-I	R-II	R-III
2	T1	138.2	153.4	170.4
3	T2	173.8	187	208.2
4	T3	218.4	216.2	247.2
5	T4	250.2	273.4	247
6	T5	163.4	206.6	157.2
7	T6	207.8	173	237.4
8	T7	268.2	180.6	226.4
9	T8	193.2	178.2	126.6
10	T9	236.8	182.6	166.2
11	T10	266.8	184.6	185.4

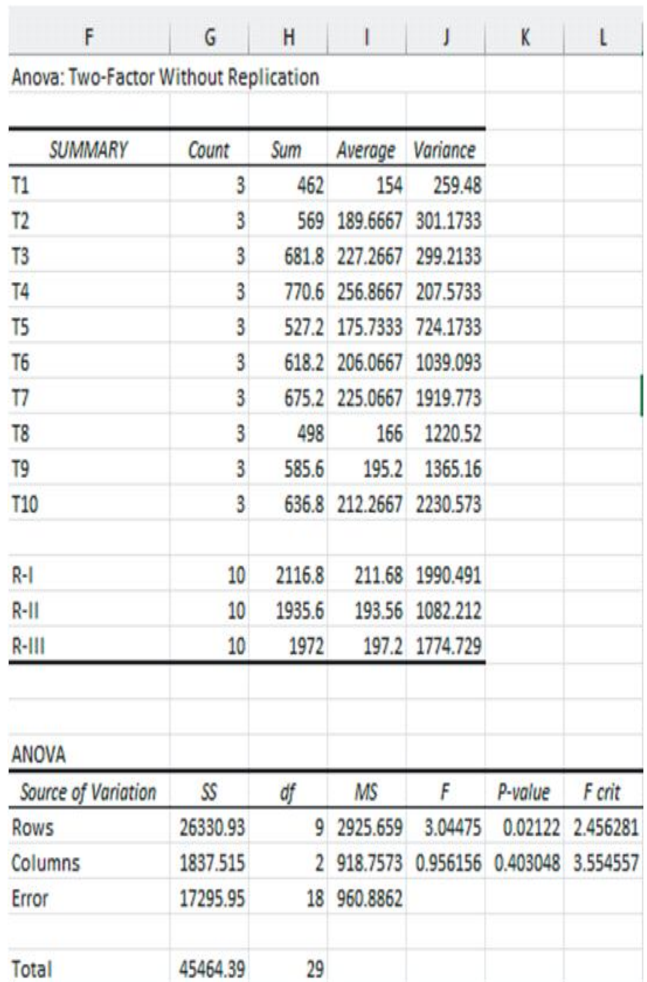
Select **Data** menu in Excel →choose **Data analysis**



choose **Anova: Two Factor Without Replication** → press **OK**



Give Input Range: **$A$1:$D$11**→ Put **tick mark** on **Labelsn** → Give **Alpha: 0.05** for 5% level of significance → Give **output Range$F$1** under Output options (*i.e.* Output will display from F1 cell) → press **OK**



Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
T1	3	462	154	259.48
T2	3	569	189.6667	301.1733
T3	3	681.8	227.2667	299.2133
T4	3	770.6	256.8667	207.5733
T5	3	527.2	175.7333	724.1733
T6	3	618.2	206.0667	1039.093
T7	3	675.2	225.0667	1919.773
T8	3	498	166	1220.52
T9	3	585.6	195.2	1365.16
T10	3	636.8	212.2667	2230.573
R-I	10	2116.8	211.68	1990.491
R-II	10	1935.6	193.56	1082.212
R-III	10	1972	197.2	1774.729

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	26330.93	9	2925.659	3.04475	0.02122	2.456281
Columns	1837.515	2	918.7573	0.956156	0.403048	3.554557
Error	17295.95	18	960.8862			
Total	45464.39	29				

In the ANOVA table of above picture, Rows means Treatments or Varieties and Columns means Blocks or replications.

Results and Discussions

Here F-cal (3.0488) value is > F-tab at 5% level of significance with $F_{k-1,(k-1)(r-1)} F_{9,18} = 2.4563$

So, we reject Null Hypothesis for treatments at 5% level of significance. *i.e.*, there is slightly significant difference among variety means.

Standard Errors

$$SEM = \sqrt{\frac{\text{Error } MSS}{r}} = \sqrt{\frac{960.8862}{3}} = 17.8968$$

$$SED = \sqrt{2} * SEM = \sqrt{2} * 17.8968 = 1.41 * 17.8968 = 25.3099$$

$$CD = SED * t_{\text{tab value at error } d.f} = 25.3099 * 2.1009 = 53.1741$$

Bar notation

T_4	T_3	T_7	T_{10}	T_6	T_9	T_2	T_5	T_8	T_1
256.87	227.27	225.07	212.27	206.07	195.20	189.67	175.73	166.00	154.00

We arrange the treatment means into decreasing order

1. Those pairs underscored are non-significant
2. Those pairs not scored are significant

Among 10 treatments, T_4 is best treatment

T_4 treatment is significantly different from T_9, T_2, T_5, T_8, T_1

$$\text{CV\%} = \sqrt{\frac{EMSS}{GM}} * 100 = \sqrt{\frac{960.8862}{200.81}} * 100 =$$

$$\frac{30.9982}{200.81} * 100 = 0.1544 * 100 = 15.44\%$$

Less CV% indicates more consistency of data.

References

Agarwal , B.L. (2009). Programmed Statistics (Questions-Answers) 2nd Edition., New Age International Publishing Limited, New Delhi.

Cini Varghese, MS-Excel:Statistical Procedures, IASRI, Library Avenue, New Delhi-110012.

Nageswara Rao, G. (2007). Statistics for Agricultural Sciences, BS Publications, Hyderabad (Second Edition).

Rangaswamy, R. (2010). A text Book of Agricultural Statistics, New Age International Publishing Limited, Hyderabad.

Srinivasa Rao, V. and R. Srinivasulu (2013). Practical manual of STCA-101 (for class use only), Agricultural College, Bapatla.