

Original Research Article

<https://doi.org/10.20546/ijcmas.2019.803.114>

Completely Randomised Design (CRD) Analysis – by Manual and MS-Excel

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ABSTRACT

Keywords

CRD, ANOVA, CD

Article Info

Accepted:

10 February 2019

Available Online:

10 March 2019

This study was attempted to find out best yield variety among 10 Gerebera varieties by using Completely Randomised Design. Terra Juba found best yield variety based on critical difference. CRD is most suitable for laboratory experiments, pot experiments and green house experiments.

Introduction

Completely randomised design is the one in which all the experimental units are taken in a single group which are homogeneous as far as possible. For example, all the field plots constituting the group are having the same soil fertility, soil depth, soil texture, soil moisture, etc.; This design is also called as non-restriction design (1, 2).

CRD follows two basic principles of experimental Designs

1. Replication
2. Randomisation

CRD follows ANOVA-Iway classification

Advantages of CRD

This design has complete flexibility, i.e., any number of treatments and replicates for each treatment can be taken,

Whole experimental material can be utilised in CRD.

CRD has maximum degrees of freedom for experimental error.

CRD layout is very easy and analysis of data is simplest as compared to any other design.

Missing observation creates no problem in analysis of data. The analysis is carried out in

the usual manner neglecting the missing plot as if it was not there in the experiment.

### Disadvantages of CRD

Local control is absent in CRD

It is applicable for homogeneous experimental units and not for heterogeneous experimental area

### Materials and Methods

In a homogeneous experimental area, a varietal trial on gerbera was conducted with 10 varieties each replicated 3 times at College of Horticulture, Venkataramannagudem in the year 2016. Flower yield in grams per plant are furnished here under analyse the data and draw your conclusion (3 ,4, 5)

	R1	R2	R3
<b>Batavia</b>	7.40	10.00	9.20
<b>Barok</b>	11.00	8.00	9.60
<b>Alcatraz</b>	11.60	10.20	11.60
<b>Faith</b>	7.60	11.20	8.00
<b>Terra juba</b>	15.00	16.40	15.20
<b>Terra dressing</b>	12.20	9.60	8.80
<b>Terra acoustic</b>	8.00	10.60	9.00
<b>Terra kline</b>	12.00	11.80	12.00
<b>Basic</b>	9.80	13.80	12.60
<b>Vesuvius</b>	12.20	10.40	9.40

Sol

		Replications			Treatment Totals	Treatment Means
		R <sub>1</sub>	R <sub>2</sub>	R <sub>3</sub>		
Treatments	<b>Batavia</b>	7.40	10.00	9.20	T <sub>1</sub> = 26.60	$\alpha_1 = \frac{T_1}{r} = \frac{26.60}{3} = 8.87$
	<b>Barok</b>	11.00	8.00	9.60	T <sub>2</sub> = 28.60	$\alpha_2 = \frac{T_2}{r} = \frac{28.60}{3} = 9.53$
	<b>Alcatraz</b>	11.60	10.20	11.60	T <sub>3</sub> = 33.40	$\alpha_3 = \frac{T_3}{r} = \frac{33.40}{3} = 11.13$
	<b>Faith</b>	7.60	11.20	8.00	T <sub>4</sub> = 26.80	$\alpha_4 = \frac{T_4}{r} = \frac{26.80}{3} = 8.93$
	<b>Terra juba</b>	15.00	16.40	15.20	T <sub>5</sub> = 46.60	$\alpha_5 = \frac{T_5}{r} = \frac{46.60}{3} = 15.53$
	<b>Terra dressing</b>	12.20	9.60	8.80	T <sub>6</sub> = 30.60	$\alpha_6 = \frac{T_6}{r} = \frac{30.60}{3} = 10.20$
	<b>Terra acoustic</b>	8.00	10.60	9.00	T <sub>7</sub> = 27.60	$\alpha_7 = \frac{T_7}{r} = \frac{27.60}{3} = 9.20$
	<b>Terra kline</b>	12.00	11.80	12.00	T <sub>8</sub> = 35.80	$\alpha_8 = \frac{T_8}{r} = \frac{35.80}{3} = 11.93$
	<b>Basic</b>	9.80	13.80	12.60	T <sub>9</sub> = 36.20	$\alpha_9 = \frac{T_9}{r} = \frac{36.20}{3} = 12.07$
	<b>Vesuvius</b>	12.20	10.40	9.40	T <sub>10</sub> = 32.00	$\alpha_{10} = \frac{T_{10}}{r} = \frac{32.00}{3} = 10.67$
					GT = 324.20	

The mathematical model for CRD is  $x_{ij} = \mu + \alpha_i + \epsilon_{ij}$

$H_0$ : There is no significant difference among mean of varieties

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

$H_1$ : There is significant difference among mean of varieties

$$H_0: \alpha_1 \neq \alpha_2 \neq \dots \neq \alpha_{10}$$

k is no. Of varieties = 10

r is no. Of replications = 3

$$GM = \frac{GT}{kr} = \frac{324.20}{10 * 3} = \frac{324.20}{30} = 10.81$$

$$CF = \frac{GT^2}{kr} = \frac{324.20^2}{10 * 3} = \frac{324.20 * 324.20}{30} = \frac{105105.64}{30} = 3503.521$$

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

$$= (7.4^2 + 10^2 + \dots + 9.4^2) - 3503.521$$

$$= 3655.56 - 3503.521 = 152.04$$

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

$$= \frac{26.6^2 + 28.6^2 + \dots + 32^2}{3} - 3503.521$$

$$= \frac{10845.08}{3} - 3503.521$$

$$= 3615.03 - 3503.521 = 111.51$$

$$Error\ SS = Total\ SS - Trt\ SS$$

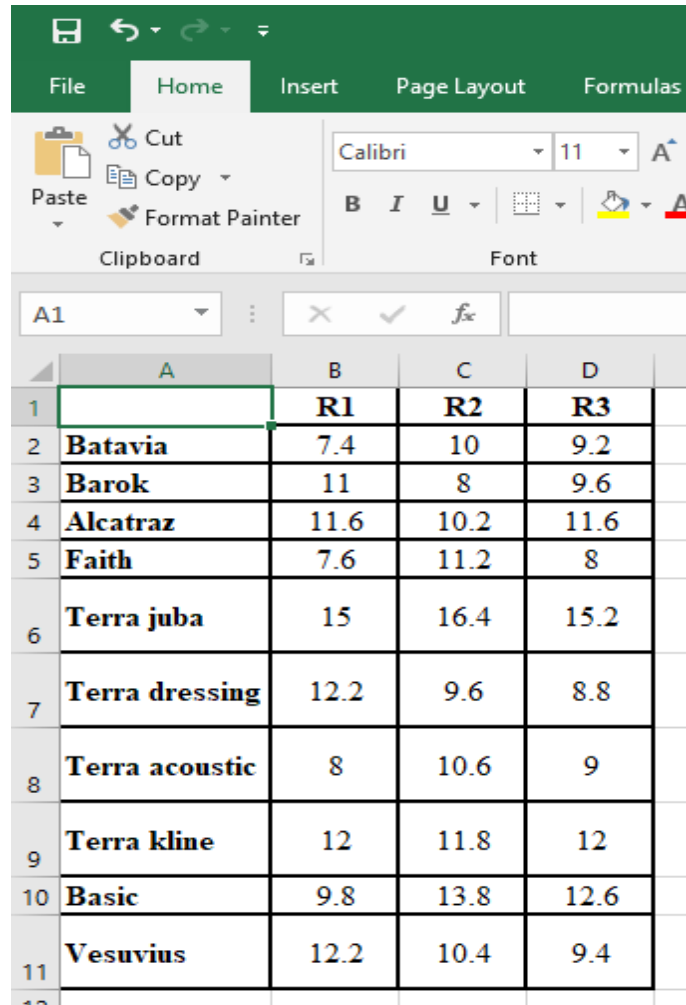
$$= 152.04 - 111.51 = 40.53$$

Prepare the following ANOVA Table

Sources Of Variation	Degrees Of freedom	Sum of Squares	Mean Sum of Squares	F-Cal	F-tab
Treatments	k-1 10-1 = 9	Trt SS = 111.51	$Trt\ MSS = \frac{Trt.\ SS}{k - 1}$ $= \frac{111.51}{9} = 12.39$	$\frac{Trt.\ MSS}{Error\ MSS}$ $\frac{12.39}{2.03} = 6.10 *$	$F_{k-1, k(r-1)}$ $F_{9, 20} = 2.39$
Error	k(r-1) 10(3-1) = 20	Error SS = 40.53	$Error\ MSS = \frac{Error.\ S}{k(r - 1)}$ $= \frac{40.53}{20} = 2.03$	---	---
Total	kr-1 10*3-1 = 29	Total SS = 152.04	---	---	---

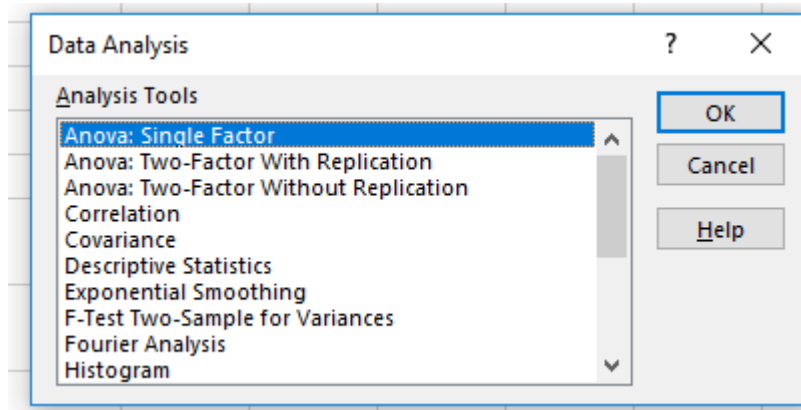
### Analysis procedure of CRD in MS-Excel

In MS-Excel sheet, enter dataas below picture

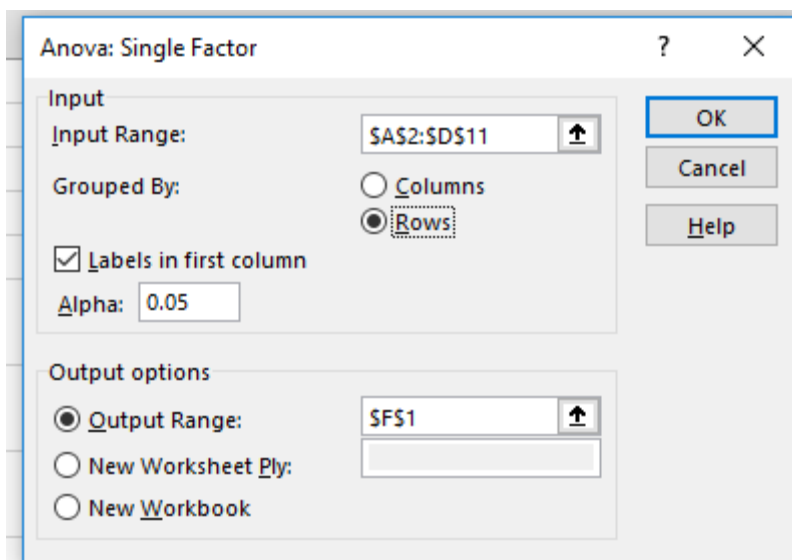


	A	B	C	D
1		<b>R1</b>	<b>R2</b>	<b>R3</b>
2	<b>Batavia</b>	7.4	10	9.2
3	<b>Barok</b>	11	8	9.6
4	<b>Alcatraz</b>	11.6	10.2	11.6
5	<b>Faith</b>	7.6	11.2	8
6	<b>Terra juba</b>	15	16.4	15.2
7	<b>Terra dressing</b>	12.2	9.6	8.8
8	<b>Terra acoustic</b>	8	10.6	9
9	<b>Terra kline</b>	12	11.8	12
10	<b>Basic</b>	9.8	13.8	12.6
11	<b>Vesuvius</b>	12.2	10.4	9.4

Select Data menu in Excel →choose Data analysis



Choose Anova: Single Factor → press OK



Give Input Range: \$A\$2:\$D\$11 → choose Rows option under Grouped By: → Put tick mark on Labels in first Column → 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

	F	G	H	I	J	K	L
	Anova: Single Factor						
	SUMMARY						
	<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
	Batavia	3	26.6	8.866667	1.773333		
	Barok	3	28.6	9.533333	2.253333		
	Alcatraz	3	33.4	11.13333	0.653333		
	Faith	3	26.8	8.933333	3.893333		
	Terra juba	3	46.6	15.53333	0.573333		
	Terra dressing	3	30.6	10.2	3.16		
	Terra acoustic	3	27.6	9.2	1.72		
	Terra kline	3	35.8	11.93333	0.013333		
	Basic	3	36.2	12.06667	4.213333		
	Vesuvius	3	32	10.66667	2.013333		
	ANOVA						
	<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
	Between Groups	111.5053	9	12.38948	6.113231	0.000377	2.392814
	Within Groups	40.53333	20	2.026667			
	Total	152.0387	29				

In the ANOVA table of above picture, Between Groups means Treatments or Varieties and Within Groups means Error

## Results and Discussion

Here, F-cal(6.10) value is > F-tab at 5% level of significance with  $F_{k-1,k(r-1)}F_{9,20} = 2.39$  and also greater than F-tab at 1% level of significance with  $F_{k-1,k(r-1)}F_{9,20} = 3.46$ . So, we reject Null Hypothesis. i.e., There is highly significant difference among variety means.

### Standard Errors

$$SEM = \sqrt{\frac{Error\ MSS}{r}} = \sqrt{\frac{2.03}{3}} = 0.82$$

$$SED = \sqrt{2} * SEM = \sqrt{2} * 0.82 = 1.41 * 0.82 = 1.16$$

$$CD = SED * t_{tab\ at\ error\ d.f} = 1.16 * 2.09 = 2.42$$

## Bar notation

We arrange the treatment means into decreasing order. Now compare treatment means difference with CD value. If the difference between treatment means is less than CD(2.42), then underline. Otherwise leave it.

- Compare mean differences of Terra Juba and Basic with CD  
15.53-12.07 = 3.46 i.e., 3.46 is greater than CD(2.42). So, don't underline between these treatments
- Compare mean differences of Basic and Terra klinewith CD  
12.07-11.93 = 0.14 i.e. 0.14 is less than CD(2.42). So, underline between these treatments

Terra juba	Basic	Terra kline	Alcatraz	Vesuvius	Terra dressing	Barok	Terra acoustic	Faith	Batavia
15.53	12.07	11.93	11.13	10.67	10.20	9.53	9.20	8.93	8.87

Those pairs underscored are Non-significant  
Those pairs not scored are Significant

In conclusion, among 10 varieties 5<sup>th</sup> variety (Terra Juba) is found best variety.

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### How to cite this article:

Sekhar, V., K. Umakrishna, V. Srinivasa Rao and Satyavani, Ch. 2019. Completely Randomised Design (CRD) Analysis – by Manual and MS-Excel. *Int.J.Curr.Microbiol.App.Sci.* 8(03): 954-959. doi: <https://doi.org/10.20546/ijcmas.2019.803.114>