RBD (Randomised Block Design) :—

In field experiment if the whole of the experimental area is not homogeneous and fertility gradient is only in one direction then a simple method of controlling variability of the experimental material is obtained by grouping or stratifying the whole experimental area into relatively homogeneous strata or sub-groups (or blocks or replicates as they are called) perpendicular to the direction of fertility gradient.

Now applying the treatments randomly to relatively homogeneous units with in each strata or block and replicated over all the blocks, the design so obtained is RBD.

Statistical Analysis of R.B.D for one obser" per cell (experimental unit)

If we use a single obser" is made for one obser" per cell then R.B.D. statistical analysis of R.B.D is analogous to ANOVA for a two-way classified data with one obser" per cell and linear model becomes:

$$y_{ij} = \mu + \tau_i + b_j + e_{ij} \quad ; \quad \begin{pmatrix} i = 1, 2, \ldots, t \\ j = 1, 2, \ldots, r \end{pmatrix}$$

where y_{ij} is the response or the yield of experimental unit from i^{th} treament and j^{th} block;
μ is the general mean effect.
τ_i is the effect due to the i^{th} treatment
b_j is the effect due to the j^{th} block or replicate and e_{ij}. e_{ij} is the error effect due to random component assumed to be independently normally distributed with mean zero and variance σ_e^2. ie e_{ij} is i.i.d. $N(0, \sigma_e^2)$
If we write

$\sum_i \sum_j y_{ij} = y_{..} = G$ = Grand total of all the $t \times r$ obser":

$\sum_j y_{ij} = y_{i.} = T_i$ = Total for i^{th} treatment

$\sum_i y_{ij} = y_{.j} = B_j$ = Total for j^{th} block

then As in ANOVA (for two-way classified), we get

$$\sum_i \sum_j (y_{ij} - \bar{y}_{..})^2 = \sum_i \sum_j (y_{ij} - \bar{y}_{i.} - \bar{y}_{.j} + \bar{y}_{..})^2 + r \sum_i (\bar{y}_{i.} - \bar{y}_{..})^2 + t \sum_j (\bar{y}_{.j} - \bar{y}_{..})^2$$

make less efficient

to the direction of fertility gradient. Now the treatments are applied at random to relatively homogeneous units within each strata or block and replicated over all the blocks. the design is called a Randomized Block Design (R.B.D).

Layout of RBD :— In agricultural agricultural experimentation, the layout of R.B.D. can be illustrated as follows.

Let us consider five treatments A, B, C, D, E, each replicated four times. We divide the whole experimental area into four relatively homogeneous strata or blocks and each block into five units or plots. Treatments are then allocated at random to the plots of a block, fresh randomisation being done for each block. A particular layout may be as follows

Block	I	A	E	B	D	C
"	II	E	D	C	B	A
"	III	C	B	A	E	D
"	IV	A	D	E	C	B

Merits of R.B.D :— (1) Accuracy (2) flexibility (3) ~~Ea~~ (3) Ease of analysis

Demerits of RBD :— R.B.D. is not suitable for large no. of treatments or for the cases in which complete block contains considerable variability.

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Or we have

$T.S.S. = S.S.E + S.S.T + S.S.B.$

where T.S.S. is total sum of square and S.S.T. S.S.B, & S.S.E are sum of square due to treatment, blocks and error respectively; given by

$$T.S.S = \sum_i \sum_j (y_{ij} - \bar{y}_{..})^2$$

$$S.S.T. = r \sum_i (\bar{y}_{i.} - \bar{y}_{..})^2 = S_T^2$$

$$S.S.B = t \sum_j (\bar{y}_{.j} - \bar{y}_{..})^2 = S_B^2$$

$$S.S.E = \sum_i \sum_j (y_{ij} - T.S.S. - S.S.T - S.S.B.$$

Hence the total sum of squares is partitioned or split into three sum of squares whose degree of freedom add to the degrees of freedom of T.S.S.

∴ By cochran's theorem each of these S.S. divided by σ_e^2 is indepthly distributed as χ^2 variate

ANOVA TABLE FOR RBD

ANOVA for R.B.D

Sources of variation	d.f	S.S	M.S.S.	Variance Ratio
treatments	$t-1$	S_T^2	$S_t^2 = \frac{S_T^2}{t-1}$	$F_T = \frac{S_t^2}{S_e^2}$
Blocks or replications	$r-1$	S_B^2	$S_B^2 = \frac{S_B^2}{r-1}$	$F_B = \frac{S_B^2}{S_e^2}$
Error or Residual	$(t-1)(r-1)$	S_E^2	$S_e^2 = \frac{S_E^2}{(r-1)(t-1)}$	
Total	$rt-1$	T.S.S.		

M.S.S. of treatments and replicates (or blocks) are used for significance against error mean S.S.

Under the null hypothesis $H_t : \tau_1 = \tau_2 = \cdots = \tau_t$ against the alternative that all τ's are not equal.

$$F_t = \frac{s_t^2}{s_e^2} \sim F_{\{(t-1),\,(t-1)(r-1)\}}$$

i.e. F_t follows F (central) dist^{n}. with $(t-1)$, $(t-1)(r-1)$ d.f.. Thus if F_T is greater than tabulated F for $(t-1)$, $(t-1)(r-1)$ d.f. at certain level of significance usually 5% then we reject the null hypothesis H_t and conclude that all treatments differ significantly.

If F_t is less than tabulated value then F_t is not significant and we conclude that the data do not provide any evidence against the null hypothesis which may be accepted.

Similarly under the null hypothesis $H_b = b_1 = b_2 = \cdots = b_r$ against the alternative that b's are not all equal

$$F_B = \frac{s_b^2}{s_e^2} \sim F_b\{r-1,\ (r-1)(t-1)\}$$

And explain its significance like τ's

Remark:- (1)

$$T.S.S. = \sum_i \sum_j (y_{ij} - \bar{y}_{..})^2 = \sum\sum y_{ij}^2 - rt\bar{y}_{..}^2$$

$$= \sum\sum y_{ij}^2 - rt\left(\frac{\sum\sum y_{ij}}{rt}\right)^2$$

$$= \sum\sum y_{ij}^2 - \frac{G^2}{N}, \quad \because N = rt$$

$$T.S.S. = R.S.S. - \frac{G^2}{N} = R.S.S. - C.F.$$

$$S.S-T. = r \sum_i (\bar{y}_{i.} - \bar{y}_{..})^2 = r\left[\sum \bar{y}_{i.}^2 - t\bar{y}_{..}^2\right]$$

$$= r\left[\left(\frac{\sum y_{i.}}{r}\right)^2 - t\left(\frac{G^2}{N}\right)\right]$$

$$= \frac{1}{r}\sum T_i^2 - C.F$$

$$= \sum_i \frac{T_i^2}{r} - C.F.$$

similarly

$$S.S.B = \frac{1}{t}\sum_j y_{.j}^2 - \frac{G^2}{N}$$

$$= \sum_j \left(\frac{B_j^2}{t}\right) - C.F.$$

$$S.S.E. = T.S.S. - S.S.T - S.S.B.$$

(2) The S.E. of any treatment mean is given by

$$Var(\bar{t}_i) = \frac{s_e^2}{r}$$

$$\Rightarrow S.E. = \sqrt{\frac{s_e^2}{r}}$$

similarly S.E. for difference bet^n any two treatment means is obtained by

$$\sqrt{\frac{2s_e^2}{r}}$$

If the treatment show significant effect, we might be interested to test for the significance of the difference bet^w any two treatment means

say $\bar{t}_i$ and $\bar{t}_j$; $i \neq j$ under the null hypothesis $\tau_i = \tau_j$ $i \neq j$

$$t = \frac{\bar{T}_1 - \bar{t}_2}{\sqrt{2s_e^2/r}} \sim \text{Student } t' \text{ dist}^n \text{ with error d.f.}$$

Viz $(r-1)(t-1)$ d.f.

and comparing the calculated value with tabulated value of t for $(r-1)(t-1)$ d.f. at, say 5% l.o.s.

Thus if F_T is rejected or is significant we have to find by which pair pairs of treatment means differ significantly.

Comparing comparing different pairs of treatment means we can find critical difference C.D.

$$C.D. = \sqrt{\frac{2s_e^2}{r}} \cdot t_{(r-1)(t-1)} \text{ d.f. (error d.f. 5\% l.o.s)}$$

The pair showing insignificant difference are underlined and then a final report based on conclusion from the analysis of experiment data with critical comments, is prepared