Table-IV $P_d \times G$ interaction table

Factor	g_1	g_2	*Totals*
p_1	73.31	86.31	159.62
p_2	72.66	98.57	171.23
p_3	91.46	93.43	184.89
Total	237.43	278.31	515.74

$$\text{S.S. }(P_d) = \frac{1}{16}\left(159.62^2 + 171.23^2 + 184.89^2\right) - \frac{515.74^2}{48}$$

$$= 5561.41 - 5541.41 = 20.00$$

$$\text{S.S }(P_d \times G) = \frac{1}{8}(73.31^2 + 86.31^2 + \text{..........} + 91.46^2 + 93.43^2) - \frac{515.74^2}{48} - 34.82 - 20.00$$

$$= 5614.17 - 5541.41 - 34.82 - 20.00 = 17.94$$

Table-V $P_d \times S$ interaction table

Factor	s_1	s_2	*Total*
p_1	89.34	70.28	159.62
p_2	95.95	75.28	171.23
p_3	91.79	93.10	184.89
Total	277.08	238.66	515.74

$$\text{S.S. }(P_d \times S) = \frac{1}{8}\left(89.34^2 + 70.28^2 + 91.79^2 + 93.10^2\right) - \frac{515.74^2}{48} - 20.00 - 30.75$$

$$= 5610.93 - 5541.41 - 20.00 - 30.75 = 18.77$$

$$\text{Factorial effects S.S.} = \frac{1}{4}\left(44.67^2 + 40.70^2 + \text{..........} + 43.32^2 + 45.84^2\right) - \frac{515.74^2}{48}$$

$$= 5676.33 - 5541.41 = 134.92$$

$$\text{S.S. }(P_d \times S \times G) = 134.92 - 34.82 - 30.75 - 20.00 - 0.52 - 17.94 - 18.77$$

$$= 12.12$$

$$\text{S.S. (Treatments)} = \frac{1}{4}\left(28.30^2 + 38.92^2 + \text{......} + 43.32^2 + 45.84^2\right) - \frac{658.87^2}{64}$$

$$= 6978.63 - 6782.96 = 195.67$$

S.E. of a mean difference between varieties at the same level of spacing by the formula (7.6.3) is,

$$S.E._{3} = \sqrt{\frac{2\times 2\times 1.732 + 2.842}{3\times 3}} = 1.042$$

S.E. of a mean difference among spacings at the same level of varieties by the formula (7.6.4) is,

$$S.E._{4} = \sqrt{\frac{2\times 4\times 1.732 + 0.698}{3\times 5}} = 0.985$$

Comparison of calculated F-values with the respective tabulated F-values for various factors reveals that there is a significant difference among varieties as well as spacings whereas the interaction V × S is non-significant. Therefore, critical differences (CD) for varieties and spacings will be worked out at 5% level of significance for comparing all pairs of variety means and spacing means.

$$CD_1 = S.E_1 \times t_{error1\ d.f.;\ .05} = 0.795 \times t_{8;\ .05}$$
$$= 0.795 \times 2.306 = 1.833$$

$$CD_2 = S.E_2 \times t_{error\ 2\ d.f.;\ .05} = 0.305 \times t_{4;.05}$$
$$= 0.305 \times 2.776 = 0.847$$

$$CD_3 = SE_3 \times t_1^*$$

where, $$t_1^* = \frac{(p-1)E_3 \times t_{error3d.f.;\alpha} + E_1 \times t_{error1d.f.;\alpha}}{(p-1)E_3 + E_1}$$

$$= \frac{4\times 1.732 \times t_{16;.05} + 2.842 \times t_{8;.05}}{4\times 1.732 + 2.842}$$

$$= \frac{4\times 1.732 \times 2.120 + 2.842 \times 2.306}{4\times 1.732 + 2.842} = 2.174$$

Thus, $CD_3 = 1.042 \times 2.174 = 2.265$

Similarly, $CD_4 = SE_4 \times t_2^*$

where, $$t_2^* = \frac{(q-1)E_3 \times t_{error3d.f.;\alpha} + E_2 \times t_{error2d.f.;\alpha}}{(q-1)E_3 + E_2}$$

$$= \frac{2\times 1.732 \times t_{16,.05} + 0.698 \times t_{4;.05}}{2\times 1.732 + 0.698}$$

$$= \frac{2\times 1.732 \times 2.120 + 0.698 \times 2.776}{2\times 1.732 + 0.698} = 2.230$$

block effects adjusted for treatments within replications. Let W_i denotes a function of the sum of blocks in which treatment i occurs. W_i can be estimated by the formula,

$$W_i = k\,T_i - (k + 1)\,B_{(i)} + G \qquad (11.6.4)$$

In the above formula, G is the grand total and $B_{(i)}$ is the sum of block totals in which the treatment i appears.

Check that, $\sum_i B_{(i)} = kG$ and $\sum_i W_i = 0$.

Sum of square due to blocks within replications adjusted for treatment effects is,

$$= \frac{\sum_i W_i^2}{k^3(k+1)} \qquad (11.6.5)$$

Analysis of variance using intrablock information will be as given in Table 11.5.2. for a simple lattice, $v = k^2$, $b = k\,(k + 1)$, $r = k + 1$, $\lambda = 1$.

Table 11.6.2. Intrablock analysis ANOVA table

Source	*d.f.*	*S.S.*	*M.S.*
Replications	k	$\frac{1}{k}\sum_u R_u^2 - C.F. = R_{yy}$	$R_{yy} / k = R_y$
Treats.(Unadj.)	$k^2 - 1$	$\frac{1}{k+1}\sum_i T_i^2 - C.F. = T_{yy}$	$T_{yy} / (k^2 - 1) = T_y$
Blocks (Adj.) within Reps.	$k^2 - 1$	$\frac{\sum_i W_i^2}{k^3(k+1)} = B_{yy}$	$B_{yy} / (k^2 - 1) = E_b$
Intrablock error	$(k - 1) \times (k^2 - 1)$	By difference $= E_{yy}$	$E_{yy} / (k - 1)(k^2 - 1) = E_e$
Total	$k^2(k + 1) - 1$	$\sum_i\sum_j\sum_u y_{iju}^2 - \frac{G^2}{k^2(k+1)} = S_{yy}$	

Where,

R_u – uth replication total for $u = 1, 2, \ldots, (k + 1)$.

G – total of all observations.

$$E_{yy} = S_{yy} - R_{yy} - T_{yy} - B_{yy}$$

Blocks	*Replication IV AB^2*			*Confounded*	*Block totals*
10	(00) V_1 22.8	(11) V_5 22.0	(22) V_9 18.3	$x_1 + 2x_2 = 0 \bmod 3$	63.1
11	(02) V_3 20.6	(10) V_4 21.5	(21) V_8 27.6	$x_1 + 2x_2 = 1 \bmod 3$	69.7
12	(01) V_2 27.2	(12) V_6 25.1	(20) V_7 20.3	$x_1 + 2x_2 = 2 \bmod 3$	72.6
Total					205.4

[Hint: $V_1, V_2, V_3, V_4, V_5, V_6, V_7, V_8, V_9 \equiv$ 00, 01, 02, 10, 11, 12, 20, 21, 22.]

Nota bene:

(*i*) Through the layout equivalence is shown between a partially confounded 3^2 factorial and simple lattice with nine non-factorial treatments.

(*ii*) x_1 shows the levels of factor A and x_2, the levels of factor B

(*iii*) This design is also a nested design as the blocks are nested within replications.

(*iv*) Block and replication totals have been worked out and placed along with the experimental data.

Calculations

Grand total, G = 807.9

$$\text{Correction factor, C.F.} = \frac{807.9^2}{36} = 18131.35$$

$$\text{Total S.S.} = 23.9^2 + 25.9^2 + \dots\dots\dots\dots + 25.1^2 + 20.3^2 - \text{C.F.}$$
$$= 18430.99 - 18131.35 = 299.64$$

$$\text{Rep.S.S.} = \frac{1}{9}(199.8^2 + 201.9^2 + \dots\dots + 200.8^2 + 205.4^2) - \text{C.F.}$$
$$= 18132.60 - 18131.35 = 1.25$$

Now various quantities required for analysis are calculated by the formulae given in the theory portion.

Table-I

Treats. T_i	*Treat. totals*	*Block totals* $B_{(i)}$	W_i	*Adj. treat.* T_i^2	*Adj. treat. mean* $\bar{T}_i'$
V_1	94.0	271.7	3.1	94.2356	23.5589
V_2	104.5	280.5	−0.6	104.4544	26.1136

(Contd.)