**LECTURE -9 –Experimental Design**

**Factorial Experiment Designing with RCBD**

This experiment is used in the case of heterogeneity of the experimental units of the factors affecting the studied trait and the possibility of homogenization in the form of blocks , as was indicated in the RCBD in one direction

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| F cal. | MS | SS | df | S.O.V |
|  |  | SSr = R – CF R | r - 1 | Blocks |
|  |  | SSt = AB – CF AB | ab -1 | treats |
|  |  | SSa = A – CF | a - 1 | A |
|  |  | SSb = B – CF | b - 1 | B |
|  |  | SSab = AB – B – A + CF | (a -1)(b - 1) | AB |
|  |  | SSe = RAB – AB – R + CF | (ab – 1)(r - 1) | Error |
|  |  | SST = RAB –CF RAB | abr – 1 | Total |

Q/ An experiment was conducted to find out the effect of birds density 7, 8 and 9 for feed conversation ratio and breeding system ( indoor , semi outdoor and outdoor , and the results were as in the following table: use factorial RCBD

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Means | ∑xi | R3 | R2 | R1 | Treats | |
| Extracts  (B) | Verities (A) |
| 1.5 | 4.6 | 1.5 | 1.5 | 1.6 | 0.0 | 44000 |
| 2.0 | 6 | 2.1 | 2.0 | 1.9 | 3% |
| 2.3 | 7.1 | 2.3 | 2.5 | 2.3 | 6% |
| 1.6 | 5 | 1.7 | 1.6 | 1.7 | 0.0 | 41066 |
| 2.3 | 6.9 | 2.2 | 2.3 | 2.4 | 3% |
| 2.4 | 7.2 | 2.4 | 2.3 | 2.5 | 6% |
| 1.8 | 5.5 | 1.8 | 1.8 | 1.9 | 0.0 | 38133 |
| 2.4 | 7.2 | 2.5 | 2.3 | 2.4 | 3% |
| 2.6 | 7.8 | 2.5 | 2.6 | 2.7 | 6% |
|  | 57.3 | 19.4 | 18.9 | 19.0 | ∑ri | |

Required:

1. Analyze the data according to Fisher's test at a significance level of 0.05?

2. Determine the best among birds densities, breeding systems, and interference at the 0.05 probability level?

3. Present the results according to the statistical analysis?

**Solution :**

Linear Model :

Yijk = µ + Ai + Bj +ABij + Pk + eijk

Where

Yijk = Observational value of the experimental unit in block K which took level i from the factor A and level j from the factor B % .

µ = over all mean

Ai= effect level i of factor A

Bj= effect level j of factor B

ABij = interaction between level i from factor A and level j from factor B

Pk : block effect k

Eijk = experimental error

Test of Hypothesis

For A , B , AB

Ho : µ1 = µ2

Ha: µ1 ≠ µ2

1- Extracting the sum of the replicates and their averages in the above table, then preparing the interaction table AB As follow

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Mean A | ∑ai | b3 | b2 | b1 | AB |
| 1.9 | 17.7 | 7.1 | 6.0 | 4.6 | a1 |
| 2.1 | 19.1 | 7.2 | 6.9 | 5.0 | a2 |
| 2.2 | 20.5 | 7.8 | 7.2 | 5.5 | a3 |
|  | 57.3 | 22.1 | 20.1 | 15.1 | ∑bi |
|  |  | 2.5 | 2.2 | 1.7 | Mean B |

2-Correction Factor

= = 121.6

3-Sum Square of Blocks R

SSr = R – CF

4-Sum Square of Factor A

SSa = A – CF

5-Sum Square of Factor B

SSb = B – CF

6-Sum Square of treatments

SSt = AB – CF AB

7-Sum Square of Interaction AB

SSab = AB – B – A + CF = 124.9 – 124.4 – 122 + 121.6 = 0.1

Sum Square of Total 8-

SST = RAB –CF RAB

= (1.6)2+... +(2.5)2=125.13 SST = 125.13 – 121.6= 3.53

9-Sum Square of Error

SSe = RAB – AB – R + CF = 125.13 – 124.9 – 121.61 + 121.6 = 0.22

10-Degree of Freedom

dft = ab – 1 = 3×3 – 1 = 8 dfr = r – 1 = 3 – 1 = 2

dfa = a – 1 = 3 – 1 = 2 dfb = b – 1 = 3 – 1 = 2

dfab = (a-1)(b-1)=2×2 = 4 dfT = abr– 1 = 27 – 1= 26

dfe= (ab-1)(r-1)=(3×3-1)(3-1)= 16

1 Mean Square 11-

= = 0.215 =

= = 0.02 = = 0.013

Analysis of Variance (ANOVA Table)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| F tab. | F cal. | MS | SS | df | S.O.V |
|  |  |  | 0.01 | 2 | Blocks |
|  |  |  | 3.3 | 8 | treats |
| 3.36\* | 16.15 | 0.21 | 0.43 | 2 | A |
| 3.36\* | 107.6 | 1.4 | 2.8 | 2 | B |
| 3.01NS | 1.53 | 0.02 | 0.1 | 4 | AB |
|  |  | 0.013 | 0.22 | 16 | Error |
|  |  |  | 3.53 | 26 | Total |

13-F. calculated

Extracting the F table value from the F-values ​​table with dfe (16) at level of 0.05 and the dfa, dfb (2) and dfab (4) .

# Since the value of Fcal for both A and B is greeter than value of F table..

∴ There are significant differences, i.e. rejecting the null theory H0 (which says that there are no significant differences) and accepting the alternative theory Ha (which says that there are significant differences) for each of the effect of birds density and breeding system, but the interaction between the two factors is not significant,

1-Comparison of averages for factor A

The value of the SSR is extracted from the SSR-Duncan table in terms of the value of dfe (16) and the probability level of 0.05

=

Then prepare a table to extract the LSR as follows

|  |  |  |
| --- | --- | --- |
| 3.15 | 3.00 | SSR |
| 0.038 | |  |
| 0.119 | 0.11 | LSR |

Then prepare a table to compare the averages of A as follows

|  |  |  |  |
| --- | --- | --- | --- |
| 0.119  a2  2.1 | 0.11  a1  1.9 | LSR | |
| Means | Treats |
| 0.1\* | 0.3\* | 2.2 | a3 |
| 0.0 | 0.2\* | 2.1 | a2 |

|  |  |
| --- | --- |
| Means | Treats A |
| 2.2 a | a3 |
| 2.1 b | a2 |
| 1.9 c | a1 |

2-Comparison of averages for factor B

|  |  |  |  |
| --- | --- | --- | --- |
| 0.119  b2  2.2 | 0.11  b1  1.7 | LSR | |
| Mean  B | Treat  B |
| 0.3\* | 0.8\* | 2.5 | b3 |
| 0.0 | 0.5\* | 2.2 | b2 |

|  |  |
| --- | --- |
| Means | Treats |
| 2.5 a | b3 |
| 2.2 b | b2 |
| 1.7 c | b1 |

3-Comparison of averages for interaction AB

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 3.41 | 3.39 | 3.37 | 3.34 | 3.3 | 3.23 | 3.15 | 3.00 | SSR |
| 0.06 | | | | | | | |  |
| 0.2 | 0.2 | 0.2 | 0.2 | 0.198 | 0.19 | 0.189 | 0.18 | LSR |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0.2  a1b3  2.4 | 0.2  a2b3  2.4 | 0.2  a3b2  2.4 | 0.2  a2b2  2.3 | 0.198  a1b2  2.0 | 0.19  a3b1  1.8 | 0.189  a2b1  1.7 | 0.18  a1b1  1.5 | Mean AB | Treat AB |
| 0.2\* | 0.2\* | 0.2\* | 0.3\* | 0.6\* | 0.8\* | 0.9\* | 1.1\* | 2.6 | a3b3 |
| 0.0 | 0.0 | 0.0 | 0.1 | 0.4\* | 0.6\* | 0.7\* | 0.9\* | 2.4 | a1b3 |
|  | 0.0 | 0.0 | 0.1 | 0.4\* | 0.6\* | 0.7\* | 0.9\* | 2.4 | a2b3 |
|  |  | 0.0 | 0.1 | 0.4\* | 0.6\* | 0.7\* | 0.9\* | 2.4 | a3b2 |
|  |  |  | 0.0 | 0.3\* | 0.5\* | 0.6\* | 0.8\* | 2.3 | a2b2 |
|  |  |  |  | 0.0 | 0.2\* | 0.3\* | 0.5\* | 2.0 | a1b2 |
|  |  |  |  |  | 0.0 | 0.1 | 0.3\* | 1.8 | a3b1 |
|  |  |  |  |  |  | 0.0 | 0.2\* | 1.7 | a2b1 |

|  |  |
| --- | --- |
| Means AB | Treats AB |
| 2.6 a | a3b3 |
| 2.4 b | a1b3 |
| 2.4 b | a2b3 |
| 2.4 b | a3b2 |
| 2.3 b | a2b2 |
| 2.0 c | a1b2 |
| 1.8 d | a3b1 |
| 1.7 d | a2b1 |
| 1.5 e | a1b1 |