**Practical No: 09**

**OBJECT:** The following table gives the result of the experiment on your varieties of a crop in 5 blocks plot

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Blocks |  |  |
| Block I | Block II | Block III | Block IV | Block V |
| A 32 | B 33 | D 30 | A 35 | C 36 |
| B 34 | C 34 | C 35 | C 32 | D 29 |
| C 31 | A 34 | B 36 | B 37 | A 37 |
| D 29 | D 26 | A 33 | D 28 | B 35 |

Analyze the above result to test whether there is significant difference between yields of four varieties. Use RBD.

**WORKING EXPRESSION:**

When the experimental material is not homogeneous the RBD is better than CRD. RBD is the design where the treatments are allocated in random manner, but randomization is the restricted that each treatment must occur once in each row or once in each column. Hence this design is row wise or column wise. It is based upon all principles of design namely replication, randomization, and local control.

Layout of RBD:

Let us consider five treatments A, B, C, D, and E each replicated four times. The treatments are allocated in the blocks as shown below.

|  |  |  |  |
| --- | --- | --- | --- |
| **BLOCK 1** | **BLOCK 2** | **BLOCK 3** | **BLOCK 4** |
| **A** | **C** | **A** | **B** |
| **B** | **A** | **B** | **C** |
| **C** | **B** | **C** | **A** |

**Mathematical Model:**

𝒚𝒊𝒋 = 𝛍 + 𝜶𝒊 + 𝜷𝒋 +𝒆𝒊𝒋; (𝒊 = 𝟏, 𝟐, … 𝒕; 𝒋 = 𝟏, 𝟐, … 𝒓)

Where,

𝒚𝒊𝒋 = 𝒕𝒉𝒆 𝒓𝒆𝒔𝒑𝒐𝒏𝒔𝒆 𝒐𝒇 𝒕𝒉𝒆 𝒋 𝒕𝒉𝐛𝐥𝐨𝐜𝐤 𝐚𝐧𝐝 𝒊 𝒕𝒉 𝒕𝒓𝒆𝒂𝒕𝒎𝒆𝒏𝒕.

𝝁 = 𝒈𝒆𝒏𝒆𝒓𝒂𝒍 𝒎𝒆𝒂𝒏 𝒆𝒇𝒇𝒆𝒄𝒕

𝜶𝒊 = 𝒕𝒉𝒆 𝒆𝒇𝒇𝒆𝒄𝒕 𝒅𝒖𝒆 𝒕𝒐 𝒊 𝒕𝒉 𝒕𝒓𝒆𝒂𝒕𝒎𝒆𝒏𝒕

𝜷𝒋 = 𝐭𝐡𝐞 𝐞𝐟𝐟𝐞𝐜𝐭 𝐝𝐮𝐞 𝐭𝐨 𝐭𝐡𝐞 𝒋 𝒕𝒉 𝒃𝒍𝒐𝒄𝒌

𝒆𝒊𝒋 = 𝒆𝒓𝒓𝒐𝒓 𝒅𝒖𝒆 𝒕𝒐 𝒄𝒉𝒂𝒏𝒄𝒆 𝐢. 𝐞. 𝒆𝒊𝒋 ~ 𝑵 (𝟎, 𝝈²𝒆)

**Hypothesis Setting:**

Null hypothesis (𝑯𝒐𝑻) (HoB): There is no significant difference between treatments.

Alternative hypothesis (𝑯𝟏𝑻) (𝑯𝟏𝑩): There is significant difference between treatment.

Total Sum of Square (TSS) = Sum of Square due to treatment (SST) + Sum of Square due to Block (SSB) + Sum of square due to Error (SSE).

TSS = SST + SSB + SSE

**ANOVA Table:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.V** | **D.F** | **S.S** | **M.S.S** | Fcal | Ftab |
| **Treatment** | **t-1** | **SST** | **MST=SST/t-1** | Ft=MST/MSE | Fα{(t-1), (t-1) (r-1)} |
| **BLOCK** | **r-1** | **SSB** | **MSS=SSB/r-1** | Fb=MSB/MSE | Fα{(r-1), (t-1) (r-1)} |
| **ERROR** | **(t-1) (r-1)** | **SSE** | **MSE=SSE/ (t-1) (r-1)** |  |  |
| **TOTAL** | **rt-1** | **TSS** |  |  |  |

Practical No: 09

Name: Aakash Shrestha

Roll No.: 02

Subject: Statistics

Date: 2080/04/21

Faculty: BSc. CSIT 3rd Semester

**OUTPUT:**

UNIANOVA Values BY Treatments Blocks

/METHOD=SSTYPE(2)

/INTERCEPT=EXCLUDE

/POSTHOC=Treatments Blocks(TUKEY)

/EMMEANS=TABLES(OVERALL)

/EMMEANS=TABLES(Treatments)

/EMMEANS=TABLES(Blocks)

/PRINT=DESCRIPTIVE

/CRITERIA=ALPHA(.05)

/DESIGN=Treatments Blocks.

**Univariate Analysis of Variance**

|  |  |  |  |
| --- | --- | --- | --- |
| **Between-Subjects Factors** | | | |
|  | | Value Label | N |
| There are 4 treatments A,B,C,D | 1.00 | A | 5 |
| 2.00 | B | 5 |
| 3.00 | C | 5 |
| 4.00 | D | 5 |
| There are 5 blocks | 1.00 | Block 1 | 4 |
| 2.00 | Block 2 | 4 |
| 3.00 | Block 3 | 4 |
| 4.00 | Block 4 | 4 |
| 5.00 | Block 5 | 4 |
|  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | |
| Dependent Variable: Values | | | | | |
| Source | Type II Sum of Squares | df | Mean Square | F | Sig. |
| Model | 21672.500a | 8 | 2709.062 | 1101.992 | .000 |
| Treatments | 134.000 | 3 | 44.667 | 18.169 | .000 |
| Blocks | 21.700 | 4 | 5.425 | 2.207 | .130 |
| Error | 29.500 | 12 | 2.458 |  |  |
| Total | 21702.000 | 20 |  |  |  |
| a. R Squared = .999 (Adjusted R Squared = .998) | | | | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **There are 4 treatments A,B,C,D** | | | | |
| Dependent Variable: Values | | | | |
| There are 4 treatments A,B,C,D | Mean | Std. Error | 95% Confidence Interval | |
| Lower Bound | Upper Bound |
| A | 34.200 | .701 | 32.672 | 35.728 |
| B | 35.000 | .701 | 33.472 | 36.528 |
| C | 33.600 | .701 | 32.072 | 35.128 |
| D | 28.400 | .701 | 26.872 | 29.928 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **There are 5 blocks** | | | | |
| Dependent Variable: Values | | | | |
| There are 5 blocks | Mean | Std. Error | 95% Confidence Interval | |
| Lower Bound | Upper Bound |
| Block 1 | 31.500 | .784 | 29.792 | 33.208 |
| Block 2 | 31.750 | .784 | 30.042 | 33.458 |
| Block 3 | 33.500 | .784 | 31.792 | 35.208 |
| Block 4 | 33.000 | .784 | 31.292 | 34.708 |
| Block 5 | 34.250 | .784 | 32.542 | 35.958 |

**Post Hoc Tests**

**There are 4 treatments A, B, C, D**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Multiple Comparisons** | | | | | | |
| Dependent Variable: Values  Tukey HSD | | | | | | |
| (I) There are 4 treatments A,B,C,D | (J) There are 4 treatments A,B,C,D | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| Lower Bound | Upper Bound |
| A | B | -.8000 | .99163 | .850 | -3.7441 | 2.1441 |
| C | .6000 | .99163 | .929 | -2.3441 | 3.5441 |
| D | 5.8000\* | .99163 | .000 | 2.8559 | 8.7441 |
| B | A | .8000 | .99163 | .850 | -2.1441 | 3.7441 |
| C | 1.4000 | .99163 | .516 | -1.5441 | 4.3441 |
| D | 6.6000\* | .99163 | .000 | 3.6559 | 9.5441 |
| C | A | -.6000 | .99163 | .929 | -3.5441 | 2.3441 |
| B | -1.4000 | .99163 | .516 | -4.3441 | 1.5441 |
| D | 5.2000\* | .99163 | .001 | 2.2559 | 8.1441 |
| D | A | -5.8000\* | .99163 | .000 | -8.7441 | -2.8559 |
| B | -6.6000\* | .99163 | .000 | -9.5441 | -3.6559 |
| C | -5.2000\* | .99163 | .001 | -8.1441 | -2.2559 |
| Based on observed means.  The error term is Mean Square(Error) = 2.458. | | | | | | |
| \*. The mean difference is significant at the .05 level. | | | | | | |

**Homogeneous Subsets**

|  |  |  |  |
| --- | --- | --- | --- |
| **Values** | | | |
| Tukey HSD | | | |
| There are 4 treatments A,B,C,D | N | Subset | |
| 1 | 2 |
| D | 5 | 28.4000 |  |
| C | 5 |  | 33.6000 |
| A | 5 |  | 34.2000 |
| B | 5 |  | 35.0000 |
| Sig. |  | 1.000 | .516 |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = 2.458. | | | |
| a. Uses Harmonic Mean Sample Size = 5.000. | | | |
| b. Alpha = .05. | | | |

**There are 5 blocks**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Multiple Comparisons** | | | | | | |
| Dependent Variable: Values  Tukey HSD | | | | | | |
| (I) There are 5 blocks | (J) There are 5 blocks | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| Lower Bound | Upper Bound |
| Block 1 | Block 2 | -.2500 | 1.10868 | .999 | -3.7838 | 3.2838 |
| Block 3 | -2.0000 | 1.10868 | .415 | -5.5338 | 1.5338 |
| Block 4 | -1.5000 | 1.10868 | .666 | -5.0338 | 2.0338 |
| Block 5 | -2.7500 | 1.10868 | .160 | -6.2838 | .7838 |
| Block 2 | Block 1 | .2500 | 1.10868 | .999 | -3.2838 | 3.7838 |
| Block 3 | -1.7500 | 1.10868 | .536 | -5.2838 | 1.7838 |
| Block 4 | -1.2500 | 1.10868 | .790 | -4.7838 | 2.2838 |
| Block 5 | -2.5000 | 1.10868 | .225 | -6.0338 | 1.0338 |
| Block 3 | Block 1 | 2.0000 | 1.10868 | .415 | -1.5338 | 5.5338 |
| Block 2 | 1.7500 | 1.10868 | .536 | -1.7838 | 5.2838 |
| Block 4 | .5000 | 1.10868 | .990 | -3.0338 | 4.0338 |
| Block 5 | -.7500 | 1.10868 | .958 | -4.2838 | 2.7838 |
| Block 4 | Block 1 | 1.5000 | 1.10868 | .666 | -2.0338 | 5.0338 |
| Block 2 | 1.2500 | 1.10868 | .790 | -2.2838 | 4.7838 |
| Block 3 | -.5000 | 1.10868 | .990 | -4.0338 | 3.0338 |
| Block 5 | -1.2500 | 1.10868 | .790 | -4.7838 | 2.2838 |
| Block 5 | Block 1 | 2.7500 | 1.10868 | .160 | -.7838 | 6.2838 |
| Block 2 | 2.5000 | 1.10868 | .225 | -1.0338 | 6.0338 |
| Block 3 | .7500 | 1.10868 | .958 | -2.7838 | 4.2838 |
| Block 4 | 1.2500 | 1.10868 | .790 | -2.2838 | 4.7838 |

**Homogeneous Subsets**

|  |  |  |
| --- | --- | --- |
| **Values** | | |
| Tukey HSD | | |
| There are 5 blocks | N | Subset |
| 1 |
| Block 1 | 4 | 31.5000 |
| Block 2 | 4 | 31.7500 |
| Block 4 | 4 | 33.0000 |
| Block 3 | 4 | 33.5000 |
| Block 5 | 4 | 34.2500 |
| Sig. |  | .160 |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = 2.458. | | |
| a. Uses Harmonic Mean Sample Size = 4.000. | | |
| b. Alpha = .05. | | |

**RESULTS:**

Post HOC Test:

For treatment: There are four treatments A, B, C, D.

For A = i.e. 0.005>0.00

For B = i.e. 0.005>0.00

For C = i.e. 0.005>0.01

For D = i.e. 0.005>0.00

i.e. 0.005>0.00

i.e. 0.005>0.01

For Blocks: There are five blocks.

For all blocks p-value > α =0.005

From Tests of Between Subjects Effects:

Mean sum of square due to treatment (MST) = 44.667

Mean sum of square due to Error (MSE) = 2.458

Mean sum of square due to block (MSB) = 5.425

**Decision:**

P-value for treatment = 0.000 < α = 0.05. Hence, we reject HoT.

Hence, we can conclude there is a significant difference between treatments.

P-value for Block = 0.130 > α =0.05. Hence, we accept HoB.

Hence, we can conclude there is no significant difference between Blocks.

**CONCLUSION:**

Hence, we have calculated the variety of crops in 5 blocks. In RBD there are treatments blocks and values. There are four treatments and five blocks. We have calculated the post Hoc tests where the mean difference is 0.05. From ANOVA table we have calculated separately for blocks and treatments using p-value and in conclusion we reject HoT(Treatments) and we accept blocks(HoB).