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EFFECT OF DETERGENTS ON CLOTH TYPES: A 2*2 FACTORIAL EXPERIMENT

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ABSTRACT

A *full factorial experiment allows studying the effect of each factor on the response variable, as well as effect of interactions between factors. There is variation in only two factors – cloth types and detergent types and all other conditions are constant. The effects of different treatment combinations are checked. The findings give the exact idea about the suitability of combination of these factors for satisfactory result. The factor with its high level (+) and low level (-) shows presence or absence in treatment combination. The factors are noted as A and B in 2*2 factorial experiment with its corresponding levels a0 and a1, as well as b0 and b1, give four treatment combinations such as a0b0 as (1), a1b0 as a, a0b1 as b and a0b0 as ab.*

INTRODUCTION

In industrial applications frequently we know that several factors may affect the characteristics in which we are interested, and we wish to estimate the effects of each of the factors and how the effect of one factor varies over the level of other factors. The logical procedure would be to vary all factors simultaneously, i.e. within the framework of the same experiment. When we do so, we have what is now widely known as a Factorial Experiment.

In the foregoing experiments performed either in C.R.D. or R.B.D. or L.S.D. we were primarily concerned with the comparison and estimation of effects of a single set of treatments. Such experiments which deal with one factor only may be called Simple Experiments.

These simple experiments do not give us any information regarding the dependence or independence of one factor on other. The only alternative is to try to investigate the variations in several factors simultaneously by conducting the above experiment as a p×q Factorial Experiment where p and q are levels of various factors under consideration. E.g. 2^3 experiment means an experiment with three factors each at two levels.

2^2 Factorial Design[1]

Here we consider two factors each at two levels (0, 1), say. So that there are 4 treatment combinations at all. Following notations are due to Yates, Let capital letters A and B indicate the names of the two factors under study and let the small letters a and b denote one of the two levels of each of the corresponding factors and this will be called the second level. The treatment combinations are as follows;

a_0b_0 , a_1b_0, a_0b_1, a_1b_1 i. e. 1, a, b, ab.

R.B.D., with r replicates, each replicate containing 4 units and ANOVA can be carried out accordingly. There are 3 d.f. associated with the treatment effects. In factorial experiments our main objective is to carry out separate tests for the main effects A, B and the interaction AB , splitting the treatment S. S. With d.f. into three orthogonal components each with 1 d. f. and each associated either with the main effects A and B or interactions AB

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EXPERIMENTAL PROCEDURE[2]

Here we have considered two factors such as detergent and cloth type each at two levels as, A : detergent: Ariel (a_0) and Tide (a_1)

B: Type of cloth: Cotton (b_0) and Cotton-Silk (b_1)

Then the treatment combinations formed as Combinations Used:

a_0b_0 – Wash the cotton cloth in Ariel.
a_1b_0 - Wash the cotton-silk cloth in Ariel.
a_0b_1 - Wash the cotton cloth in Tide.
a_1b_1 - Wash the cotton-silk cloth in Tide.

Previously we use five dirt spots on each type of cloth by spreading oil, soil, ink, tea, and turmeric. Then we count the remaining spot on cloth after wash. And form a data table bellow

DATA TABLE 1[2]

Type of Cloth	Detergent Used	Original Dirt Spots	Remaining Spots			Average
Cotton (b_0)	Ariel(a_0)	5	3	2	3	2.67
Cotton silk(b_1)	Ariel(a_0)	5	3	3	3	03
Cotton(b_0)	Tide(a_1)	5	1	2	1	1.33
Cotton silk(b_1)	Tide(a_1)	5	0	2	2	1.33

MATHEMATICAL MODEL[1]

$$\mathbf{Y_{ij} = \mu + \tau_i + \beta_j + \epsilon_{ij}}$$

Where,

μ=General mean effect.
τ_i=Effect due to i^{th} treatment, i = 1,2,3,4
β_j = Effect due to j^{th} block (replicates), j = 1,2,3
ϵ_{ij} are independently identically distributed follows $N(0, \sigma_e^2)$.

HYPOTHESES:

- $\mathbf{H_{01}}$: Replications not show significant effect on removal of dirt spots.
  $\mathbf{H_{11}}$**:** Replications show significant effect on removal of dirt spots.
- $\mathbf{H_{02}}$**:** Treatment not show any significant effect on removal of dirt spots.
  $\mathbf{H_{12}}$**:** Treatment show significant effect on removal of dirt spots.
- $\mathbf{H_{03}}$: Cloth type does not show significant effect on removal of dirt spots.
  $\mathbf{H_{13}}$: Cloth type show significant effect on removal of dirt spots.
- $\mathbf{H_{04}}$: Type of detergent does not show significant effect on removal of dirt spots.
  $\mathbf{H_{14}}$**:** Type of detergent show significant effect on removal of dirt spots.
- $\mathbf{H_{05}}$: Interaction not show significant effect on removal of dirt spots.
  $\mathbf{H_{15}}$: Interaction show significant effect on removal of dirt spots.

ANALYSIS:

Yates Table for main Effects

Treatment combination	Total yield from all replicates			Effect Total
1	2.67	2.67+3=5.67	5.67+2.66=8.33	Grand Total=8.33
a	3	1.33+1.33=2.66	0.33+0=0.33	[A]=0.33
b	1.33	3-2.67=0.33	2.66-5.67=(-3.01)	[B]=(-3.01)
ab	1.33	1.33-1.33=0	0-0.33=(-0.33)	[AB]=(-0.33)

ANOVA TABLE

Source of variation	Degrees of freedom	Sum of squares	Mean sum of squares	Variance ratio "F"	Tabulated "F"
Blocks Replicates	3-1=2	S_r^2=10.25	S_R^2=5.125	3.7512	0.9530
Treatment Effects	3	S_t^2=4.001	S_T^2 =1.33	0.98	0.98
Main Effect For Cloth [A]	1	S_a^2=0.009	S_A^2=0.009	0.973	0.8374
Main Effect For Detergent[B]	1	S_b^2=0.75	S_B^2=0.75	0.5489	0.8374
Interaction [AB]	1	S_{ab}^2=0.009	S_{AB}^2 =0.009	0.0065	0.8374
Error	3(by subtraction)	S_e^2=4.0986	S_E^2=1.3662		
Total	12-1=11	S_t^2=10.92			

Table3

RESULTS

- As 3.7512 > F(0.05,2,3) = 0.9530
  The hypothesis $H_{01}$is rejected.
  Hence replication shows significant effect on removal of dirt spots.
- As 0.98 = F(0.05,3,3) = 0.98
  The hypothesis H_{02} is rejected.
  Hence Treatment shows significant effect on removal of dirt spots.
- As 0.973 > F(0.05,1,3) = 0.8374
  The hypothesis H_{03} is rejected.
  Hence Cloth type shows significant effect on removal of dirt spots.
- As 0.5489 < F(0.05,1,3) = 0.8374
  The hypothesis H_{04} is accepted.
  Hence Detergent not shows significant effect on removal of dirt spots.
- As 0.0065 < F(0.05,1,3) = 0.8374
  The hypothesis H_{05} is accepted.
  Hence Interaction not shows significant effect on removal of dirt spots.

CONCLUSIONS

Removal of dirt spots is depends on cloth type.
Both the detergent shows same effect on removal of dirt spot.
Both the detergents work same and remove most spots on cotton-silk cloth.
Removal of dirt spots from cotton cloth is quite difficult but Ariel works better than Tide.
Best treatment combination as per the experiment is cotton-silk with any type of detergent.

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