STRIP-PLOT ANALYSIS FOR THE CONSTRUCTION OF COMPLETE TRIPARTITE AND CUBIC GRAPHS

V. Saranya

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Research Scholar, Department of Statistics, Periyar University, Salem, Tamil Nadu, India

saranya88stat@gmail.com

S. Kavitha

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Assistant Professor, Department of Statistics, Periyar University, Salem, Tamil Nadu, India

pustatkavitha@gmail.com

Abstract

The Strip-Plot Design (SPD) is plays an important role in the complete block designs and also using the agricultural, medical and industry fields. SPD is best suited for a two-factor experiment that has more treatments than can be accommodated by a complete block design. In a SPD, one factor is assigned to the horizontal strip plot, one factor is assigned to the vertical – strip plot and one factor is interaction plot. Also, few experimental materials may be rare while other test items may be available in altering doses of other therapeutic factors, which may be expensive or time-consuming. One of the main features of SPD involves three types of experimental errors: row - strip plot error, coloum – strip plot error and interaction plot error. Experimenting across processing steps is essential for studying the interaction of factors where certain factors come from one step and others arrive from the other. The strip-plot design is a very efficient design for investigating multiple-step processes in terms of both resources and time. Strip-plot designs are economical when the factors are hard to change and the process under research has three discrete stages. When we want to study interactions between factors where some factors are from one step and other factors from another step, it is important to conduct experiments across processing steps. The approach is flexible because it can handle experimental design problems involving factors acting at different levels, unlike the existing method. Graphs are widely used representations of both natural and human-made structures. Graph theory can be used to investigate "things that are connected to other things. "Fits nearly everywhere. Some tough problems become easier to solve when they are represented graphically. We reviewed the agricultural field yield of the strip-plot design and early work on the design of industrial strip-plot design in this paper. We have also described the model of strip-plot design. We, therefore, advise experimenters to ensure that their strip-plot designs contain a sufficient number of rows and columns so that valid statistical inference is possible. A bipartite graph is one in which the edges can be divided into two sets without going into sets. A complete bipartite graph is a bipartite graph that is completed. The complete tripartite graph in which the edges can be divided into three set without going into sets. The cubic graph is a graph in which all vertices have degree three. This paper describes the construction and Statistical Analysis of SPD using some particular types of graphs is discussed through numerical examples.

Keywords: Strip -plot design, complete tripartite graph, cubic graph

1. Introduction

India is the third-largest producer of cotton in the world. Cotton grows well in drier parts of the, black soil, red soil and alive soil of the Deccan plateau. It requires high temperature, light rainfall or irrigation, 210 frost-free days and bright sunshine for its growth. It is a Kharif crop and requires 6 to 8 months to mature. The challenge is developing design organizations that meet quality and cost criteria. Every attempt at agricultural science research includes the design of experiments. Suppose to investigate more than one factor simultaneously in a single experiment, which is called the factorial experiment of the design.

Some factors to be tested need bigger plots, and others require smaller plots. Different plots are required in such cases, and the resulting design is known as split plot design (SPD). In 1925, Fisher developed this design for the purpose of agricultural experiments. The cost of the experiment can often be reduced by avoiding complete randomization.

The strip- plot design (SPD) is essential in complete block designs and applications in agriculture, medicine, and industry. One component is assigned to the horizontal strip plot, one to the vertical strip plot, and one to the interaction plot in an SPD.

Graph theory is one of the fastest-growing sciences. Graphs in their applications, are commonly used to represent distinct objects and the relationship between these objects. The visual representation of a graph is the declaration of an object vertex, while the relationship between objects is expressed as an edge. In recent years, graph theory has established itself as an important mathematical tool in various subjects, from available research and chemistry to genetics and linguistics and from electrical engineering and geography to sociology and architecture in its own right. At the same time is mathematical to discipline in its own right. Peter Horak et al. [1] have focused on this result is a special case of a general conjecture made by Erdos and NeSetiil: For each $d \geq 3$, the edge set of a graph of maximum degree d can always be partitioned into $[5d^2/4]$ subsets, each of which induces a matching. Raymond Greenlaw and Rossella Petreschi [2] have developed a new algorithm is presented for cubic graphs.

Arden Miller [3] has focused on using statistical experimental designs Strip-Plot Configurations of Fractional Factorials. George A. et al. [4] have discussed the strip-plot design for two-step processes. Elizabeth J. et al. [5] have reviewed recent developments and provided guidelines for using the Decomposition of complete tripartite graphs into gregarious 4-cycles. Heidi Arnouts et al. [6] have focused on the Strip-plot experiments, and the cost of experimentation can often be reduced by forgoing complete randomization. Antal Ivanyi et al. [7] have developed an exchange algorithm for tripartite graphs with given degree set. Abdollah Khodkar [8] has discussed the signed edge domination numbers of complete tripartite graphs. Sheikh Rashid et al. [9] has discussed the study of cubic graphs with its application and introduced certain concepts, including cubic graphs, internal cubic graphs, and external cubic graphs, and illustrate these concepts by examples. Velimor D. et al. [10] have presented the procedure for complete tripartite graphs with spanning maximal planar subgraphs.

Peter Bradshaw [11] has focused on vertex-disjoint triangles as a "tratching." The problem of finding a tratching that covers all vertices of a tripartite graph can be shown to be NP-complete using a reduction from the three-dimensional matching problem. K Nisa et al. [11] have discussed the Analysis of variance for strip plot design with missing values: bias correction of the mean squares. Hossein Rashmansloua et al. [13] discussed about cubic graphs with novel application and define the direct product. we introduce the notion of complete cubic graphs and present some properties of self-complementary cubic graphs. Peter Goos [14] has reviewed recent developments and provided guidelines for using the fish patty experiment: a strip-plot look. This paper discussed a statistical analysis of SPD using complete tripartite and cubic graphs with a numerical example.

2. Preliminaries

2.1 Strip – Plot Design

In strip plot design, each block is divided into several vertical and horizontal strips depending on the levels of the individual factors. Therefore, the Analysis of strip plot design is carried out in three parts. The first part is the vertical strip analysis, the second part is the horizontal strip analysis, and the third is the interaction analysis.

2.2 Complete Tripartite Graph

A complete tripartite graph is a set of vertices split into three disjoint sets such that no two graph vertices within the same set are adjacent and every vertex in one set is adjacent to every vertex in the other two sets. If the three sets contain p, q, and r graph vertices, a complete tripartite graph.

2.3 Cubic Graph

In the mathematical field of graph theory, a cubic graph is one in which all vertices have degree three. In other words, a cubic graph is a three-regular graph. Cubic graphs are also called trivalent graphs.

3. Statistical Analysis of Strip – Plot Design

The linear model for strip-plot design is

$$Y \quad = \mu + \tau_i + \beta_j + (\tau\beta)_{ij} + \gamma_k + (\tau\gamma)_{ik} + (\qquad + \varepsilon \qquad i=1,2\ldots r,\ \ j=1,2\ldots v, k=1,2\ldots n \tag{1}$$

Y_{ijk} is observation corresponds to the kth level of factor (A), j^{th} level of factor (A) and i^{th} replication. μ the general mean effect.
τ_j is i^{th} block effect, A is the j^{th} level of factor A, B is the k^{th} level of factor B.
is the interaction between j^{th} level factor A and k^{th} level factor B, the error components.
and ε_{ijk} are independently and normally distributed with means zero and respective variance σ_a^2, σ_b^2 and σ_ε^2.

In statistical analysis, separate estimates of error are obtained for the main effects of the factors A and B and their interaction $A.B$. Thus, three mean error squares will be applicable for testing the significance of the main results of the characteristics and their interaction separately.

The vertical strip plot for the first factor, the horizontal strip plot for the second factor, and the vertical and horizontal bars in the interaction strip plot for the interaction between two factors are always perpendicular to each other. The correlation plot is very small and primarily illustrates the interaction between the two design factors. As a result, we may say that correlation is assessed more precisely in strip plot design.
This is an outline of the variance analysis table:

- Correction factor (C.F.) = $\frac{}{}$
- Total sum of square (SST) =
- Replication sum of square (SSR) = $\frac{}{} - C$
- Horizontal factor sum of square (S.S. (H.F.)) = $\frac{}{} - C$
- Horizontal factor error sum of square (SSE_a) = $\frac{}{} - \quad - S \quad -$

- Vertical factor sum of square (S.S. (V.F.)) = $\frac{}{} - C$
- Vertical factor error sum of square (SSE_b) = $\frac{}{} - \quad - SSR -$
- Interaction effect sum of square = $\frac{}{} - \quad - SSA -$
- Interaction error sum of square (SSE_c) = SST- (All other sum of square)

Table 1: *ANOVA table for strip – plot design*

Sv	Df	Ss	Mss	F-Ratio
R. (R)	(r-1)	SSR		
H.F. (A)	(a-1)	SSA		
H.F.E. (a)	(r-1)(a-1)	SSEa		-
V.F. (B)	(b-1)	SSB		
V.F.E.(b)	(r-1)(b-1)	SSEb		-
I.E. (AB)	(a-1)(b-1)	SSAB		
I.E. (c)	(r-1)(a-1)(b-1)	SSEc		-

4. Construction of Strip – Plot Design using Graphs

4.1. Method for Construction for Tripartite Graph

- Let us consider the horizontal strip, vertical strip, and intersection plots as vertex set Q. This vertex set P can be divided into three subsets: Q1, Q2, and Q3.
- Then the replication is considered as the first subset Q1, variety as the second subset Q2, and Soils as the third subset Q3.
- Now consider the first (replication) vertex (R_1) of the first subset, and then R_1 is connected to all the vertices of the second and third subset through edges.
- Next, consider the second replication vertex (R_2). It's connected to all the vertices of the second and third subsets through the edges.
- Similarly, all the remaining replication vertices of the first subset are connected to all the vertices of the second and third subsets through the corresponding edges.
- Finally, we get the complete tripartite graph for the vertical strip, horizontal strip, and intersection plots.

4.1.1 Application

In our study, to collect the yields of primary data on cotton cultivation varieties at Salem District of Tamilnadu. Three replicates of various cotton varieties (LRA(P.T.), Supriya, Surabhi) in kilograms and three Soil (Black, Red, and Alive). The four replications of Cotton cultivation in kilograms for yields per plot, three varieties of crops are tested, the layout being Strip plot design data is given below.

Table 2: *Replication wise data for yield of cotton (kg/ha)*

Replication	R_1	R_2	R_3	R_4
Variety	Soil(S_1)			
V_1	3328	3258	3400	3128
V_2	3220	3150	3115	3015
V_3	2850	2800	2700	2625
	Soil(S_2)			
V_1	2814	2750	2915	2963
V_2	2656	2655	2500	2700
V_3	2515	2514	2415	2400
	Soil(S_3)			
V_1	3050	3118	3250	3150
V_2	2950	3000	3065	2950
V_3	2650	2750	2950	2800

Table 3: *Replication ×variety for horizondal factor*

	V_1	V_2	V_3	Replication Total
R_1	9192	8826	8015	26033
R_2	9126	8805	8064	25995
R_3	9565	8680	8003	26248
R_4	9241	8665	7825	25731
Variety Total	37124	34976	31907	104007

The complete tripartite graph construction method for horizontal – strip plot is given below.

- From the above table 3 vertex is fixed as Q, which is divided into three subsets, the figure 1 shows that Q_1 (replication), Q_2 (variety) and Q_3 (soils).
- The figure 2 shows that first replication vertex (R_1) connected to all the vertices of variety (V_1, V_2 and V_3) through the edge values 9192(Y_1), 8826(Y_2), and 8015(Y_3).

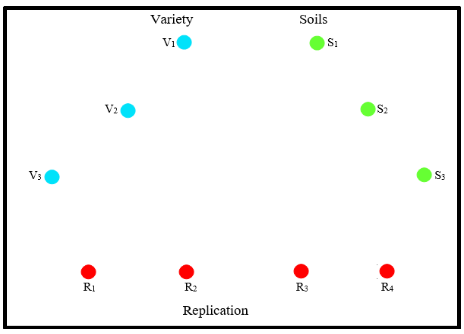

Figure 1: *Graph of subsets*

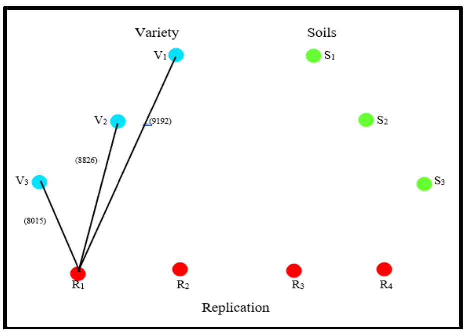

Figure 2: *Graph for first replication* (R_1)

- The figure 3 shows that second replication vertex (R_2), and it is connected to all the vertices of variety (V_1, V_2, and V_3) through the edge values 9126(Y_1), 8805(Y_2), and 8064(Y_3).
- Similarly, the figure 4 shows that third and fourth replication vertices (R3 and R_4) are connected to all the vertices of variety (V_1, V_2 and V_3) through the

corresponding edge values. (Y_1, Y_2 and Y_3) 9565, 8680, and 8003 (Y_1, Y_2 and Y_3)9241, 8665, and 7825.

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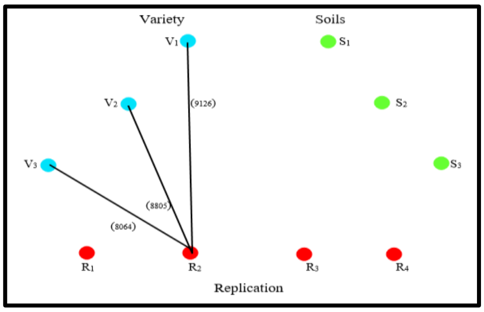

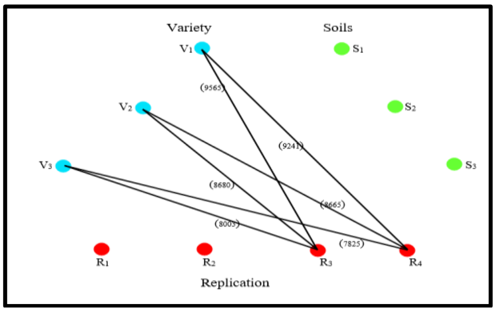

Figure 3: *Graph for second replication* (R_2) **Figure 4:** *Graph for third and fourth replication* (R_3 and R_4)

- The figure 5 shows that complete tripartite graph of variety and replication for the horizontal - strip plot.

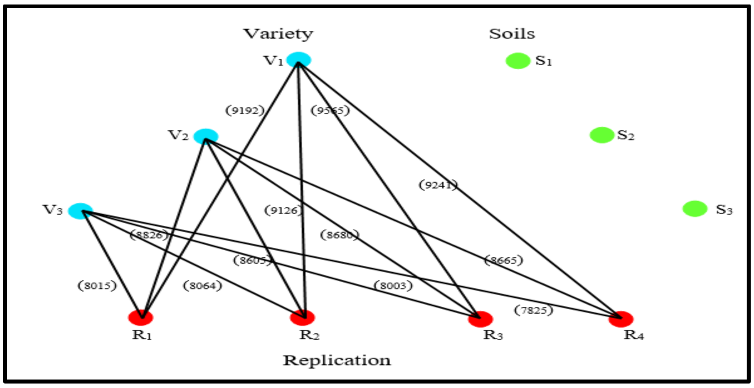

Figure 5: *Graph for complete tripartite graph of horizondal – strip plot*

Table 4: *Replication × soils for vertical factor*

	S1	S2	S3	Replication Total
R1	9398	7885	8650	26033
R2	9208	7919	3868	25995
R3	9215	7830	9203	26248
R4	8768	8063	8900	25731
Soils Total	36589	31797	35621	104007

The construction method of the complete tripartite graph for vertical – strip plot is given below

- From the above table 4 that first replication vertex (R_1). The figure 6 shows that first replication vertex is connected to all soils (S_1, S_2 and S_3) through the values 9398, 7985, and 8650(Y_1, Y_2 and Y_3).
- The figure 7 shows that second replication vertex (R_1). The second replication vertex is connected to all Soils (S_1, S_2 and S_3) through the values 9208, 7919, *and* 8868 (Y_1, Y_2 and Y_3).

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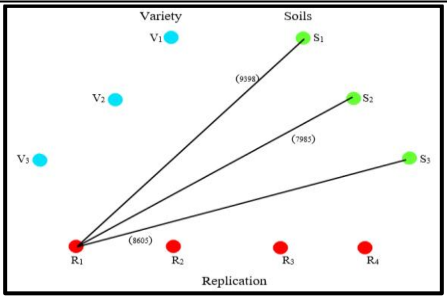

Figure 6: *Graph for first replication (R_1)*

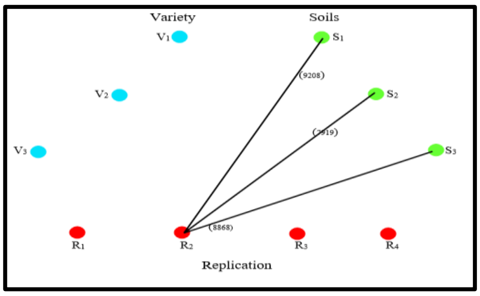

Figure 7: *Graph for second replication (R_2)*

- Similarly, the figure 8 shows that third and fourth replication vertices (R_3 and R_4) are connected to all the vertices of soils (S_1, S_2 and S_3) through the corresponding edge values. 9215, 7830 and 9203 (Y_1, Y_2 and Y_3) 8768, 8063 and 8900 (Y_1, Y_2 and Y_3).
- The figure 9 shows that complete tripartite graph for replication and soils vertical - strip plot.

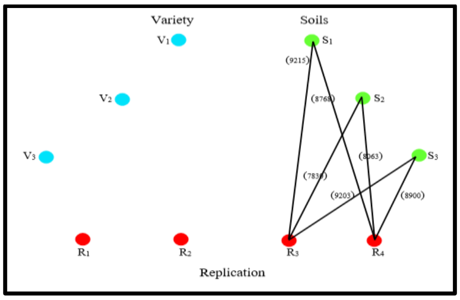

Figure 8: *Graph for third and fourth replication (R_3 and R_4)*

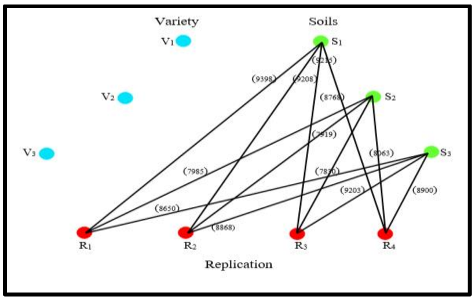

Figure 9: *Complete tripartite graph of vertical Strip - plot*

Table 5: *Variety × soils for interaction plot*

	S_1	S_2	S_3	Variety Total
V_1	13114	11442	12568	37124
V_2	12500	10511	11965	34976
V_3	10975	9844	11088	31907
Soils Total	36589	31797	35621	104007

The construction method of complete tripartite graph for interaction plot are given below

- The above table 5 that first variety vertex (V_1). The first variety vertex is connected to all soils (S_1, S_2 and S_3) through the values 13114, 11442 and12568 (Y_1, Y_2 and Y_3).

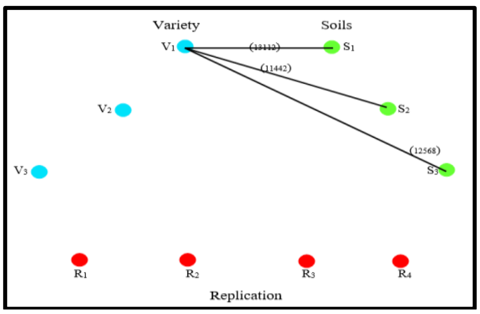

Figure 10: *Graph for first variety (V_1)*

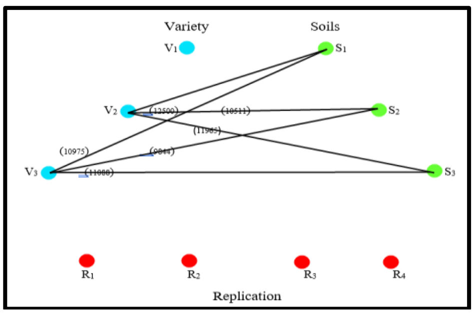

Figure 11: *Graph for second and third variety(V_2andV_3)*

- Similarly, the figure 11 shows that second and third verities vertexes (V_2 and V_3) are connected to all the Soils (S_1, S_2 and S_3)., through the corresponding values 12500,10511 and 11965(Y_1, Y_2 and Y_3) *10975, 9844* and *11088* (Y_1, Y_2 and Y_3).
- The figure 12 shows that complete tripartite graph for the variety and soil interaction plot.

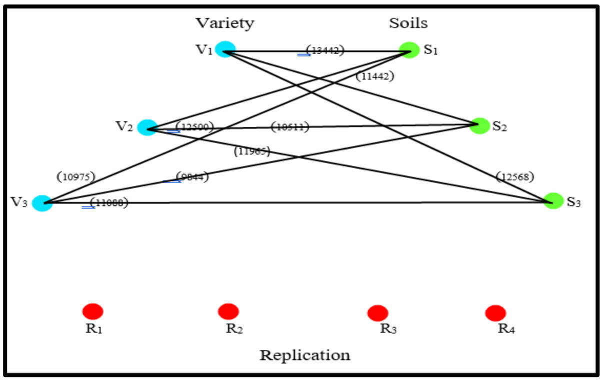

Figure 12: *Complete tripartite graph for interaction plot*

- The figure 13 shows that complete tripartite graph for replication and variety, replication and soils, and variety and soils.

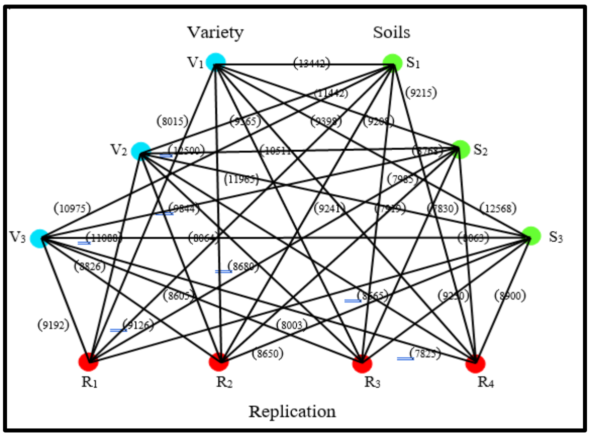

Figure 13: *Complete tripartite graph for horizondal, vertical and interaction strip plot*

Compute the correction factor and sum of squares as

- Correction factor (C.F.) = 300484890.3
- Total sum of square (SST) = 2490006.7

Compute the sum of squares for the horizontal analysis:

- Replication sum of square (SSR) = 14996.256
- Horizontal factor sum of square (S.S. (H.F.)) = 1145826.5
- Horizontal factor error sum of square (SSE_a) = 40929.8

Compute the sum of squares for the vertical analysis:

- Vertical factor sum of square (S.S. (V.F.)) = 1070090.6
- Vertical factor error sum of square (SSE_b) = 118191.7

Compute the sum of squares for the interaction analysis:

- Interaction effect sum of square = 59701.4
- Interaction error sum of square (SSE_c) = 40.271

Table 6: *ANOVA for strip plot design*

Sv	D.f	Ss	Mss	F-Ratio	P-Value
Replication	3	14996.256	4998.752	1.36467	0.26720020
Variety(A)	2	1145826.5	572291325	83.9847	-
Error(E_a)	6	40929.8	6821.633	-	-
Soils(B)	2	1070090.6	535040.33	27.161314	0.00100000
Error(E_b)	6	118191.7	19698.617	-	-
Interaction(A×B)	4	59701.4	14925.35	4.44747	0.01958176
Error (E_c)	12	40271	3355.916	-	-
Total	35	-	-	-	-

The table value of replication and variety is greater than the calculated values. So the null hypothesis is accepted. There is no significant difference between the four replications and the three varieties. The table value of soils is greater than the calculated value. So the null hypothesis is accepted. There is no significant difference between the three soil levels. The table value of the interaction effect is also more important than the calculated value. So the null hypothesis is accepted.

There is no significant difference between the interaction effects. The P-value of the above experiment is more significant than the 5% significance level. Therefore the null hypothesis is accepted. There is no significant difference that occurred in the above experiment.

4.2 Method for Construction of Cubic Graph

- Let us consider the horizontal-strip plot, vertical–strip plot, and interaction plot factors as vertex set Q. Then the elements are divided into two subsets, Q_1 and Q_2.
- Then the replication is considered the first subset Q_1 and variety as the second subset Q_2.
- Now consider the first (replication) vertex R_1 of the first subset and then R_1 is connected to all the vertices of the second subset through edges.
- Next, consider the second replication vertex R_2 it is connected to all the vertices of the second subset through the edges.
- Similarly, all the remaining replication vertices of the first subset are connected to all the vertices of the second subset through the corresponding edges.
- Finally, we get the cubic graph for horizontal, vertical, and interaction plots.

4.2.1 Application

In our study, to collect the kilometers of primary data on petrol two-wheeler brands at Salem District of Tamilnadu. Three replicates of various two-wheeler brands (Honda, Tvs, Suzuki), in kilometers and three route way of (Hillstration, City, Highways). The four replications of petrol in kilometers per litter, three brands of kilometres are tested, and the layout being Strip plot design data is given below.

Table 7: *Day wise for kilometres of petrol*

Days	D_1	D_2	D_3
Brand	Route(R_1)		
B_1	30	31	31
B_2	35	34	34
B_3	33	32	33
	Route(R_2)		

B_1	35	36	37
B_2	42	40	41
B_3	37	38	39
	Route(R_3)		
B_1	50	51	50
B_2	57	55	56
B_3	54	53	54

Table 8: *Days × brand for horizondal factor*

	B_1	B_2	B_3	Days Total
D_1	115	134	124	373
D_2	118	129	123	370
D_3	118	131	126	375
Brand Total	351	394	373	1118

The construction method of cubic graph for horizontal–strip plot is given below.

- From the above table 8 vertex is fixed as Q, which is divided into two subsets, the figure 14 shows that Q_1 (days) and Q_2 (brand).
- The figure 15 shows that first day vertex (D_1). The first days vertex is connected to all brand (B_1, B_2 and B_3) through the values 115(Y_1), 134(Y_2), 124(Y_3).

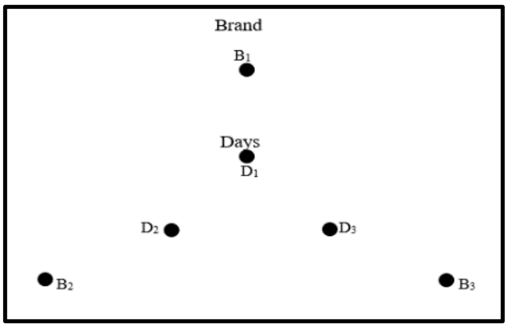

Figure 14: *Graph of subsets*

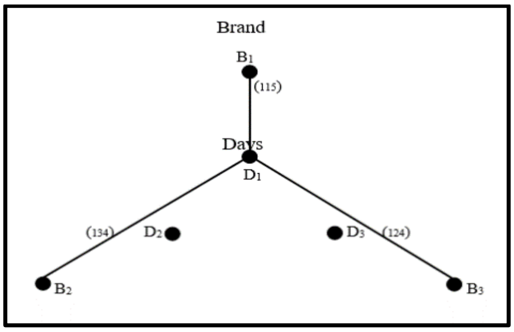

Figure 15: *Graph of first day (D_1)*

- Similarly, the figure 16 shows that second and third day vertex (D_2 and D_3). The second and third days vertex is connected to all brand (B_1, B_2 and B_3) through the values 118, 129, and 123(Y_1, Y_2 and Y_3), 118, 131 and 126 (Y_1, Y_2 and Y_3).
- The figure 17 shows that cubic graph for days and brand.

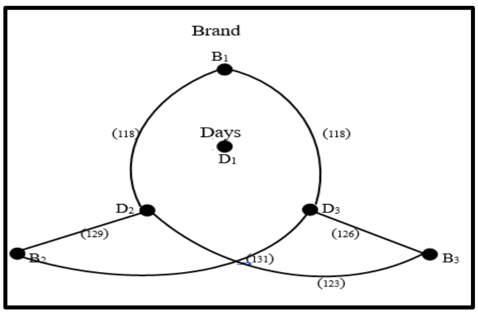

Figure 16: *Graph of second and third days (D_2 and D_3)*

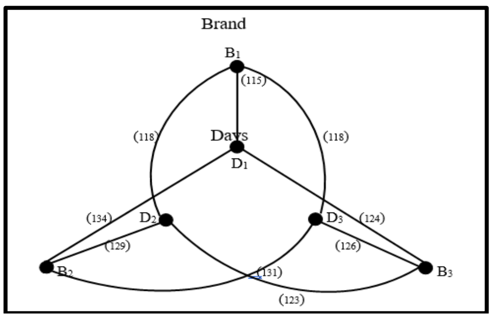

Figure 17: *Cubic graph for horizontal – strip plot*

Table 9: *Days × route for vertical factor*

	R_1	R_2	R_3	Days Total
D_1	98	114	161	373
D_2	97	114	159	370
D_3	98	117	160	375
Route Total	293	345	480	1118

The construction method of the cubic graph vertical–strip plot is given below.

- From the above table 9 vertex is fixed as Q, which is divided into two subsets, the figure 18 shows that Q_1 (days) and Q_2 (route).
- The figure 19 shows that first day vertex (D_1). The first days vertex is connected to all Route (R_1, R_2 and R_3) through the values 98(Y_1), 114(Y_2), 161(Y_3).

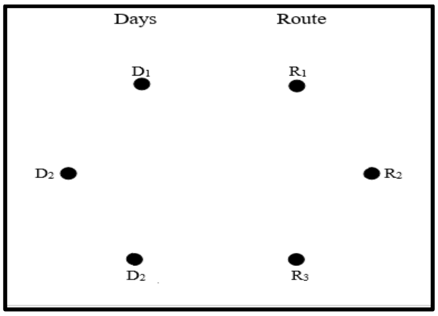

Figure 18: *Cubic graph for subset*

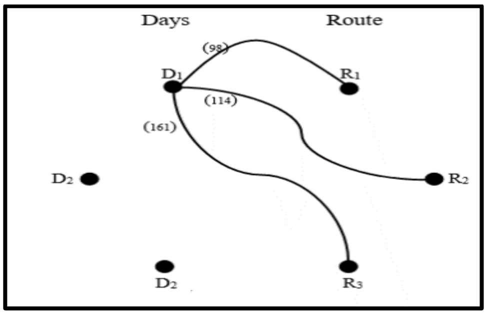

Figure 19: *Cubic graph for first day (D_1)*

- Similarly, the figure 20 shows that second and third day vertex (D_2 and D_3). The second and third day vertex is connected to all routes (R_1, R_2 and R_3), through the values 97, 114 and 159(Y_1, Y_2 and Y_3), 98, 117 and 160 (Y_1, Y_2, and Y_3).
- The figure 21 shows that cubic graph for days and route.

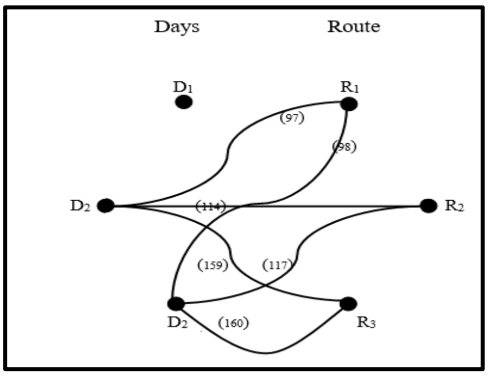

Figure 20: *Cubic graph for second and third days (D_2 and D_3)*

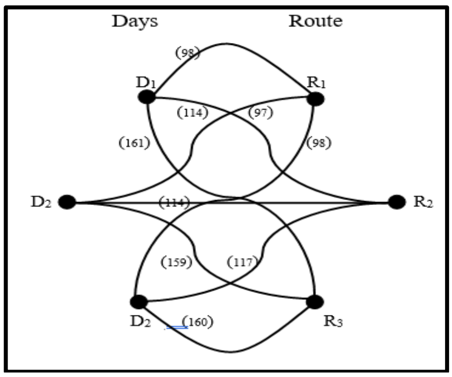

Figure 21: *Cubic graph for vertical – strip plot*

Table 10: *Brand × route for Interaction factor*

	R_1	R_2	R_3	Brand Total
B_1	92	108	151	351
B_2	103	123	168	394
B_3	98	114	161	373
Route Total	293	345	480	1118

The construction method of the cubic graph for the Interaction strip plot is given below.

- From the above table 10 vertex is fixed as Q, which is divided into two subsets, the figure 22 shows that Q_1 (brand) and Q_2 (route).
- The figure 23 shows that first vertex (R_1). The first route vertex is connected to all brand *(B_1, B_2 and B_3)* through the values 92(Y_1), 108(Y_2), 151(Y_3).

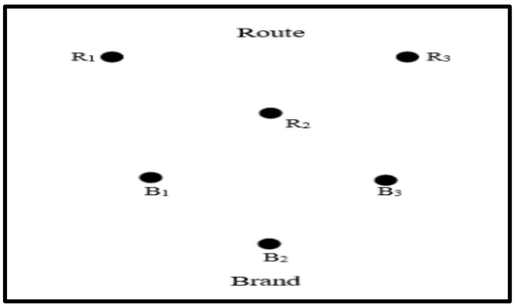

Figure 22: *Cubic graph for subset*

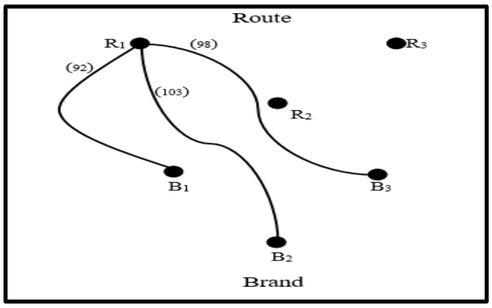

Figure 23: *Cubic graph for first brand (B_1)*

- Similarly, the figure 24 shows that second and third route vertex (R_2 and R_3). The second and third route vertex is connected to all brand (*B_1, B_2,* and *B_3*), through the values 103, 123, and 168 (Y_1, Y_2 and Y_3), 98, 114, and 161 (Y_1, Y_2 and Y_3).
- The figure 25 shows that cubic graph for route and brand.

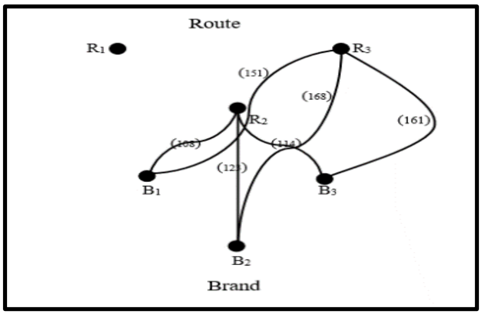

Figure 24: *Cubic graph for second and third brand (B_1 and B_3)*

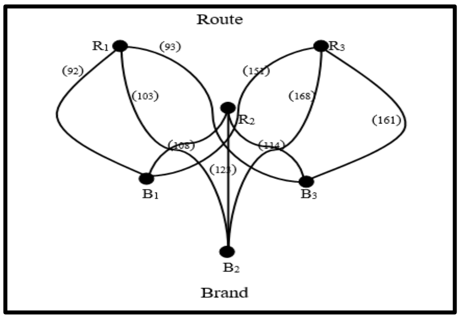

Figure 25: *Cubic graph for interaction Strip - plot*

Compute the correction factor and sum of squares as

- Correction factor (C.F.) = 46293.48148
- Total sum of square (SST) = 2188.51852

Compute the sum of squares for the horizontal analysis:

- Replication sum of square (SSD) = 1.4074
- Horizontal factor sum of square (S.S. (H.F.)) = 102.7407
- Horizontal factor error sum of square (SSE_a) = 6.3704

Compute the sum of squares for the vertical analysis:

- Vertical factor sum of square (S.S. (V.F.)) = 2070.2963
- Vertical factor error sum of square (SSE_b) =1.43096

Compute the sum of squares for the interaction analysis:

- Interaction effect sum of square = 4.1477
- Interaction error sum of square (SSE_c) = 2.37456

Table 11: *ANOVA for strip plot design*

Sv	D.f	Ss	Mss	F-Ratio	P-Value
Replication	2	1.4074	0.7037	2.263180	0.12596233
Brand(A)	2	102.7407	51.3704	32.25563	-
Error(E_a)	4	6.3704	1.5926	-	-
Route(B)	2	2070.2963	1035.14815	2795.884156	0.00000000
Error(E_b)	4	1.48096	0.37024	-	-
Interaction(A×B)	4	1.48096	1.036925	3.4934472	0.04526749
Error (E_c)	8	4.1477	0.29682	-	-
Total	26	2.37456	-	-	-

The table values of replication and brand method are more significant than the calculated values. So the null hypothesis is accepted. There is no significant difference between the three replications and the three-route method. The table value of the route method is greater than the calculated value. So the null hypothesis is accepted. There is no significant difference between the three route methods. The table value of the interaction effect is also more effective than the calculated value. So the null hypothesis is accepted. There is no significant difference between the interaction effects.

The P-value of the above experiment is more significant than the 5% significance level. Therefore the null hypothesis is accepted. There is no significant difference that occurred in the above experiment.

5. Conclusion

Many real-world experiments deviate from textbook examples and sometimes involve multiple types of structures. Running agricultural and industrial tests in strip plot analysis is an effective method to reduce costs. The strip-plot design is the most efficient design in terms of both the resources required and the time required to study multi-step processes. This paper describes the construction and analysis of strip-plot analysis using some particular type of graphs through numerical examples from different fields, the hypothesis testing is compared by the strip-plot ANOVA method with the software using the method. When comparing the results of these methods, they produce the same results. Here some particular type of graphs is used to construct the *SPD*. In the future, there is an idea to expand this procedure to other experimental designs, such as Split-Split Plot Designs, Incomplete Block Designs etc.

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List of Abbreviation

Sv - Sources of variance
D.f - Degrees of freedom
Ss - Sum of squares
Mss - Mean sum of squares
R. (R) - Replication (R)
H.F. (A) - Horizontal Factor(A)
H.F.E. (a) - Horizontal Factor Error (a)
V.F. (B) - Vertical Factor(B)
V.F.E. (b) - Vertical Factor Error (b)
I.E. (AB) - Interaction Effect (AB)
I.E.(c) - Interaction Error(c).