



CHAPTER XI

Statistical analysis

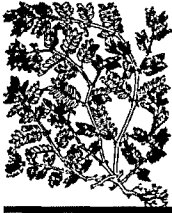


F-STATISTIC ANALYSIS:

In order to get certain positive results with few calculation and with greater efficiency means of multisamples can be compared using a different test. Such a test involving many samples is known as analysis of variance.

The-analysis is directed to (1) Variation between the treatments which are ordinarily shown in columns of table (2) Variation in the individual items of a particular treatment such as pot numbers, leaf numbers or such replicates which are shown in rows. One has to find out where these variations are significant it so what is the degree α . 01 level of significance F Statistic which a ratio of variance can be calculated using the following procedure and compared with the tabulated values of F. to draw a conclusion.

To find out the variance ratio F, the deviations are dealt in two parts : (1) Deviation due to treatment effect and (2) Deviation due to random differences in the individual items with in treatment. Thus deviation due to all observations deviations due to treatment effect only and deviation due to random differences with in treatments are the three type of deviations which are needed in the calculation.



$$F = \frac{B-D}{U-1} \bigg/ \frac{(A-D) - (B-D)}{U(V-1)}$$

$$A = \sum X^2, \quad B = \left[\frac{(\sum X_1)^2}{n_1} + \frac{(\sum X_2)^2}{n_2} + \frac{(\sum X_3)^2}{n_3} \right]$$

$$D = \frac{(\sum X)^2}{n}$$

U = Number of Columns

V = Number of Rows

CORRELATION COEFFICIENT:

Existence of certain relationship between two characters or items are felt without any definite pattern. In fact two sets of variables may have certain relationship between themselves or may not have any. In other words the relationship would reveal whether a change in one variable would cause changes in other variable or not. When two variables move together we become assured that they are related or correlated. The relationships existing between two sets of variables is expressed quantitatively exhibiting a degree of relationship among the variables and called correlation in biostudies, Bodington stated that whenever definite connection exists between two or more groups, classes or series of data, there is said to be correlation.



The degrees of relationship between two variables may be established with a (quantitative) expression by calculating a coefficient called “Correlation Coefficient, which gives a qualitative measure of the degree of closeness of the linear relationship between the two variables. The correlation coefficient is expressed by r and determined using the formula after Carl Pearson as follows:

$$r = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2 \sum (y - \bar{y})^2}}$$

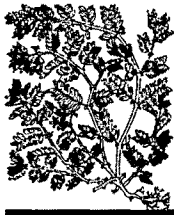
Where

x = Independent Variable

Y = Dependent Variables

$(x - \bar{x})$ and $(y - \bar{y})$ = deviations from the respective means,

In above formula if “ d ” may be used to denote deviation from mean, then dx will stand for $(x - \bar{x})$ and dy for $(y - \bar{y})$. Thus formula for r may be written as follows:



$$r = \frac{\sum dx dy}{\sqrt{\sum dx^2 \cdot \sum dy^2}}$$

It may be simplified for various component as follows: dx by can be positive or negative depending upon whether the correlation is positive or negative.

The correlation coefficient, r is purely a number without any unit and it fluctuates between -1 to +1, When r=+1, indicate a perfect positive correlation, however if indicative of perfect negative correlation. Whereas, the correlation coefficient is zero when there is no correlation at all, i.e. when the degree of scattering is very large. In the biostudies it is very difficult to find out a perfect positive (i.e. +1) or perfect negative (i.e. -1) correlations, although value of r in some cases may be 0.999.

OBSERVATIONS:

The value of r are computed in the following (tables 11.1-11.31) for various properties.



Table 11.1

FOR TSP in Different Seasons at the Various Study Sites ($p < 0.01$)

Source of	SOS	df	MS	F	Tab. Value'
Among Group	11306488.4	5	2261297.6	-	3.45
•				13,6	
Within Group	8270456.6	48	172301.1		2.40

Significant at 1% Level.

Table-11.2

FOR SO₂ content in Different Seasons at the Various Study Sites ($p > 0.01$)

Source of Variances	SOS	df	MS	F	Tab.F
Among Group	33710,7	5	6742.1		
				17.92	4.76
Within Group	18059.4	48	376.2		

Significant at 1% Level.

Table 11.3

For NO₂ content in Different Seasons at the varioius
Study Site (p=<0.01)

Source of Variances	SOS	MS	df	F
Among Group	25035	5210.9		74.36
With Group	3277.9	65.82		

Significant at 1% Level

Table 11.4

For Dust Fall During Different Seasons at the varioius
Study Site (p=<0.01)

Source of Variances	SOS	MS	df	F
Among Group	71.84	14.36	5	95.33
With Group	5.49	11.4	48	

Significant at 1% Level

Table 11.5

For Physical Characteristic of soil Different
Study Sites ($p < 0.01$)

Source of Variances	SOS	MS	df	F
Among Group	11574	2314.7	5	18.5
With Group	2977.9	124.07	24	

Significant at 1% Level

Table 11.6

For Physical Characteristic of soils Different
Study Sites ($p < 0.01$)

Source of Variances	SOS	MS	df	F
Among Group	11432	23124.7	5	17.5
With Group	2977.9	123.06	24	

Significant at 1% Level

Table 11.7

For Chemical Characteristic of soils Different
Study Sites ($p < 0.01$)

Source of Variances	SOS	MS	df	F
Among Group	10.22	2.44	5	98.7
With Group	-0.7382	0.0246	30	

Significant at 1% Level

Table 11.8

For Effect of SO₂ on Growth Parameters
of *T. Terrestris* ($p < 0.01$)

Source of Variances	SOS	MS	df	F
Among Group	711.42	237.14	3	9.06
With Group	992.28	26.17	36	

Significant at 1% Level

Table 11.9

For Dry Weight Fraction of NPP of *T. Terrestris* L, Exposed to SO_2
at 0.25ppm. ($p < 0.05$)

Source of Variances	SOS	MS	df	F
Among Group	2.6631	0.887706	3	3.28
With Group	3.1472	0.18736	36	

Significant at 1% Level

Table 11.10Analysis of Variance for Effect of SO₂ on Mean Leaf Area

Source	df	SS	MS	F. Ratio
Tr.	5	4689.8446	937.9689	36.54**
Har.	3	10739.9956	3616.5319	410.90**
SP	1	32.3179	23.3179	1.25
Tl	1	1457.8951	1357.8951	56.79**
Tr × Har	15	4046.6726	269.7781	10.51
Tr × SP	5	54.1933	10.8386	0.42
Tr × Tl	5	502.0549	100.41909	2.91**
Har × Tl	3	933.9517	311.3172	11.13**
Har × SP	3	133.575	44.255	1.73
SP × Tl	1	53.2083	53.2083	2.07
Residual	53	1360.3669	53.2083	
Total	95	24004.0759		

** Significant at 1% Level.

*** Significant at 5% Level.

Table 11.11Analysis of Variance for Effect of SO₂ on Mean Leaf Area

Source	df	SS	MS	F. Ratio
Tr.	5	740.8328	148.1665	4.20**
Har.	3	47883.656	15961.1186	152.82**
SP	1	170.1513	170.1513	4.82***
Tl	1	120.2096	120.2096	3.41
Tr × Har	15	425.1349	28.3423	0.8
Tr × SP	5	644.9526	128.9905	3.65**
Tr × Tl	5	544.4583	108.6336	3.22***
Har × T l	3	87.2196	29.0732	0.82
Har × SP	3	568.7131	189.571	5.37
SP × Tl	1	124.5679	124.5679	3.53
Residual	53	1868.1585	35.2482	
Total	95	53178.0546		

** Significant at 1% Level.

*** Significant at 5% Level.

Table 11.12
Analysis of Variance for Effect of SO₂ on LWR

Source	df	SS	MS	F. Ratio
Tr.	5	0.1842	0.0368	7.51**
Har.	3	0.2446	0.0815	16.63**
SP	1	0.102	0.102	20.81**
Tl	1	0.0675	0.0675	13.77**
Tr × Har	15	0.0201	0.0013	0.27**
Tr × SP	5	0.2451	0.04906	10.00**
Tr × Tl	5	0.2291	0.0339	9.383**
Har × T l	3	0.0054	0.00018	0.36
Har × SP	3	0.0483	0.0161	3.28***
SP × Tl	1	0.0421	0.0421	8.59**
Residual	53	0.2618	0.0049	

Table 11.3

For NO₂ content in Different Seasons at the various
Study Site (p=<0.01)

Source of Variances	SOS	MS	df	F
Among Group	25035	5210.9		74.36
With Group	3277.9	65.82		

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Among Group	10.22	2.44	5	98.7
With Group	-0.7382	0.0246	30	

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Source of Variances	SOS	MS	df	F
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Table 11.12
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Source	df	SS	MS	F. Ratio
Tr.	5	0.1842	0.0368	7.51**
Har.	3	0.2446	0.0815	16.63**
SP	1	0.102	0.102	20.81**
Tl	1	0.0675	0.0675	13.77**
Tr × Har	15	0.0201	0.0013	0.27**
Tr × SP	5	0.2451	0.04906	10.00**
Tr × Tl	5	0.2291	0.0339	9.383**
Har × Tl	3	0.0054	0.00018	0.36
Har × SP	3	0.0483	0.0161	3.28***
SP × Tl	1	0.0421	0.0421	8.59**
Residual	53	0.2618	0.0049	
Total	95	1.4502		

** Significant at 1% Level.

*** Significant at 5% Level.

Table 11.13Analysis of Variance for Effect of SO₂ on S / R Ratio

Source	df	SS	MS	F. Ratio
Tr	5	70.7276	14.1455	10.36**
Har.	3	107.0056	35.6685	26.14**
SP	1	59.0658	59.0658	43.30**
Tl	1	0.2519	0.2419	0.18
Tr × Har	15	19.7319	1.3154	0.96
Tr × SP	5	71.1569	14.2313	10.43**
Tr × Tl	5	49.9803	9.876	7.32**
Har × T l	3	6.11	2.0371	1.49
Har × SP	3	7.7616	2.5872	1.89
SP × Tl	1	0.145	0.145	0.1
Residual	53	72.2989	1.3641	
Total	95	464.2355		

** Significant at 1% Level.

Table 11.14Analysis of Variance for Effect of SO₂ on S / R Ratio

Source	df	SS	MS	F. Ratio
Tr	5	9.905	1.981	1.81
Har.	3	177.8328	59.2776	54.41**
SP	1	33.4587	33.4587	30.71**
Tl	1	5.3923	5.3923	4.95**
Tr × Har	15	3.9322	0.2621	0.24
Tr × SP	5	12.3045	0.4609	2.25
Tr × Tl	5	19.0881	3.8176	3.50**
Har × T l	3	3.5225	1.1741	1.07
Har × SP	3	74.528	24.8426	22.80**
SP × Tl	1	0.5999	0.5999	0.55
Residual	53	57.7356	1.0893	0.1
Total	95	398.2996		

** Significant at 1% Level.

** Significant at 5% Level.

Table 11.15Analysis of Variance for Effect of SO₂ on LWR Ratio

Source	df	SS	MS	F. Ratio
Tr	5	0.4041	0.0808	17.56**
Har.	3	0.0832	0.0277	6.02**
SP	1	0.08553	0.0853	18.54**
Tl	1	0.127	0.0127	2.76
Tr × Har	15	0.0342	0.0022	0.49
Tr × SP	5	0.1272	0.0254	5.53**
Tr × Tl	5	0.1721	0.0244	6.98**
Har × Tl	3	0.0359	0.09119	2.58
Har × SP	3	0.025	0.0183	2.71
SP × Tl	1	0.0034	0.0034	0.73
Residual	53	0.2153	0.0046	
Total	95	1.31293		

** Significant at 1% Level.

Table 11.16Analysis of Variance for Effect of SO₂ on SLA Ratio

Source	df	SS	MS	F. Ratio
Tr	5	0.2399	0.0479	2.58***
Har.	3	0.227	0.0075	0.4
SP	1	0.0001	0.0001	7
Tl	1	0.1727	0.1727	9.33**
Tr × Har	15	0.0763	0.005	1.27
Tr × SP	5	0.189	0.0378	2.04
Tr × Tl	5	0.4615	0.0923	4.98**
Har × T l	3	0.1201	0.400	2.16
Har × SP	3	0.0635	0.0211	1.14
SP × Tl	1	0.024	0.21	1.29
Residual	53	0.983	0.0185	
Total	95	2.5571		

** Significant at 1% Level.

Table 11.17Analysis of Variance for Effect of SO₂ on SLA Ratio

Source	df	SS	MS	F. Ratio
Tr	5	0.0921	0.0184	4.28**
Har.	3	0.0525	0.0175	0.06***
SP	1	0.1226	0.1226	28.51**
Tl	1	0.181	0.0181	4.20**
Tr × Har	15	0.0387	0.0025	0.6
Tr × SP	5	0.1343	0.0268	6.24**
Tr × Tl	5	1.1352	0.027	6.28**
Har × T l	3	0.0039	0.0013	0.3
Har × SP	3	0.1148	0.0382	8.89**
SP × Tl	1	0.0163	0.0163	3.79
Residual	53	0.2329	0.0043	
Total	95	2.1243		

** Significant at 1% Level.

** Significant at 5% Level.

Table 11.18Analysis of Variance for Effect of SO₂ on RGR Ratio

Source	df	SS	MS	F. Ratio
Tr	5	1.0407	0.2081	5.15**
Har.	2	0.2087	0.104	2.57
SP	1	0.378	0.0378	0.93
Tl	1	0.8083	0.8083	20.00**
Tr × Har	10	0.6218	0.0621	1.53
Tr × SP	5	0.1800	0.036	0.89
Tr × Tl	5	0.4407	0.881	2.18
Har × Tl	2	0.1912	0.955	2.35
Har × SP	2	0.0588	0.0294	0.72
SP × Tl	1	0.0140	0.014	0.34
Residual	37	1.4979	0.0404	
Total	71	5.4401		

** Significant at 1% Level.

Table 11.19
Analysis of Variance for Effect of SO₂ on RGR Ratio

Source	df	SS	MS	F. Ratio
Tr	5	0.4746	0.949	4.00**
Har.	2	0.5158	0.2579	10.88**
SP	1	0.0245	0.02579	1.03**
Tl	1	0.1000	0.0245	4.21**
Tr × Har	10	0.2145	0.1000	8.9
Tr × SP	5	0.4301	0.0214	3.62**
Tr × Tl	5	0.4084	0.086	3.44***
Har × Tl	2	0.0033	0.0816	0.06
Har × SP	2	1.259	0.0016	26.56**
SP × Tl	1	0.0698	0.6295	2.94
Residual	37	0.8778	0.0698	
Total	71	4.3778		

** Significant at 1% Level.

** Significant at 5% Level.

Table 11.20Analysis of Variance for Effect of SO₂ on NAR Ratio

Source	df	SS	MS	F. Ratio
Tr	5	27.8558	5.57711	4.7763**
Har.	2	9.7643	4.8821	4.1856
SP	1	0.2609	0.2609	0.2236
Tl	1	14.3638	14.3638	12.3146**
Tr × Har	10	13.1854	1.3855	1.1878
Tr × SP	5	15.2424	3.0484	2.6135***
Tr × Tl	5	15.0867	3.017	2.5868**
Har × T l	2	7.9173	3.9586	3.3938**
Har × SP	2	2.481	1.2405	1.0635
SP × Tl	1	4.8911	4.8911	4.1933***
Residual	37	43.1603	1.4664	
Total	71	154.209		

** Significant at 1% Level.

** Significant at 5% Level.

Table 11.21Analysis of Variance for Effect of SO₂ on NAR Ratio

Source	df	SS	MS	F. Ratio
Tr	5	22.299	4.4598	7.50**
Har.	2	28.8826	14.4413	24.30**
SP	1	6.0807	6.0807	10.23**
Tl	1	2.2137	2.3137	3.89
Tr × Har	10	5.356	0.5356	0.90
Tr × SP	5	12.8191	2.5638	4.31**
Tr × Tl	5	10.0331	2.011	3.38***
Har × T l	2	0.0844	0.0422	0.07
Har × SP	2	21.7055	10.8527	18.26
SP × Tl	1	3.1111	3.1111	5.23***
Residual	37	21.9878	0.5942	
Total	71	134.573		

** Significant at 1% Level.

** Significant at 5% Level.

Table 11.22Analysis of Variance for Effect of SO₂ on LAR Ratio

Source	df	SS	MS	F. Ratio
Tr	5	0.0456	0.0091	4.33**
Har.	2	0.515	0.171	8.17**
SP	1	0.0037	0.0037	1.76
Tl	1	0.0219	0.0219	10.42**
Tr × Har	10	0.0132	0.0009	0.41
Tr × SP	5	0.0274	0.0044	2.60***
Tr × Tl	5	0.0734	0.015	6.99**
Har × T l	2	0.0103	0.0034	1.63
Har × SP	2	0.0184	0.0061	2.90***
SP × Tl	1	0.0009	0.0009	0.42
Residual	37	0.1126	0.0021	
Total	71	0.8424		

** Significant at 1% Level.

** Significant at 5% Level.

Table 11.23Analysis of Variance for Effect of SO₂ on LAR Ratio

Source	df	SS	MS	F. Ratio
Tr	5	0.0164	0.0032	4.20**
Har.	2	0.0162	0.0054	0.92**
SP	1	0.047	0.047	60.21**
Tl	1	0.0083	0.0083	10.64**
Tr × Har	10	0.0042	0.0002	0.35
Tr × SP	5	0.0332	0.0066	8.51**
Tr × Tl	5	0.0365	0.007	9.35**
Har × Tl	2	0.0000	0.0000	0.000
Har × SP	2	0.0267	0.0089	11.41**
SP × Tl	1	0.0035	0.0035	0.487**
Residual	37	0.0415	0.0007	
Total	71	0.2335		

** Significant at 1% Level.

** Significant at 5% Level.

Table 11.24Analysis of Variance for Effect of SO₂ on RGR Leaf

Source	df	SS	MS	F. Ratio
Tr	5	0.05019	0.7003	1.4030
Har.	2	3.2397	1.6198	3.2448
SP	1	0.0560	0.0560	0.1121
Tl	1	0.0089	0.0089	0.0178
Tr × Har	10	5.6522	0.5842	1.1322
Tr × SP	5	2.3274	0.4654	0.9324
Tr × Tl	5	4.271	0.8542	1.7111
Har × T l	2	3.8918	1.8959	3.8980***
Har × SP	2	3.6518	1.8259	3.6576***
SP × Tl	1	0.0460	0.046	0.0921
Residual	37	18.4724	0.4992	
Total	71	41.66739		

** Significant at 1% Level.

Table 11.25Analysis of Variance for Effect of SO₂ on RGR Leaf

Source	df	SS	MS	F. Ratio
Tr	5	0.7500	0.1500	4.20**
Har.	2	0.1175	0.0587	1.6400
SP	1	0.0070	0.0070	0.1900
Tl	1	0.1186	0.1186	3.3200
Tr × Far	10	0.2437	0.0243	0.6800
Tr × SP	5	0.7277	0.1455	4.07**
Tr × Tl	5	0.4400	0.0830	2.46***
Har × Tl	2	0.0031	0.0015	0.0400
Har × SP	2	0.9061	0.453	12.69**
SP × Tl	1	0.0888	0.0888	2.4800
Residual	37	1.3231	0.0357	
Total	71	4.7256		

** Significant at 1% Level.

Table 11.26

For Effect of SO₂ exposure in various concentration for
60 days in T.terrestris L (p=<0.01)

Source of Variances	SOS	MS	df	F
Among Group	3217.4	804.36	4	587.98
With Group	41.04	1.368	40	

Significant at 1% Level

Table 11.27

For Effect of SO₂ exposure in various concentration for
60 days in T.terrestris (p=<0.01)

Source of Variances	SOS	MS	df	F
Among Group	785.61	196.4	4	47.58
Within Group	123.18	4.106	30	

Significant at 1% Level

Table : 11.28

For Cumulative doses of SO₂ NO_x Pollutants which induced foliar injury in T. Terrestris (p < 0.01)

Source of Variances	SOS	MS	df	F	
Among Group	534.54	277.27	2	3.48	No Significant
Within Group	457.56	50.84	9		
Among Group	370.96	185.48	2	3.64	No Significant
Within Group	458.31	50.92	9		

Table : 11.29

For Leaf area injury leaf, leaf area reduction in leaves of T. Terrestris
($p < 0.01$)

Source of Variances	SOS	MS	df	F	
Among Group	7794.54	3897.27	2	29.9	No Significant
Within Group	1911.35	127.422	15		
Among Group	7531	3765.82	2	29.9	No Significant
Within Group	2132.03	142.13	15		

Table : 11.30

For Percentage Variation in Nitrogen & Sulphur Content of of T. Terrestris
($p < 0.01$)

Source of Variances	SOS	MS	df	F	
Among Group	10.17	2.034	5	0.73	No Significant
Within Group	82.55	2.75	30		
Among Group	35.22	7.04	5	3.53	No Significant
Within Group	59.84	1.994	30		

Table : 11.31
 For Variation in Calcium Contents of of T. Terrestris
 (p=<0.01)

Source of Variances	SOS	MS	df	F	
Among Group	60.35	12.7	5	167.1	No Significant
Within Group	2.29	0.076	30		
Among Group	0.04	0.008	5	0.615	No Significant
Within Group	0.415	0.013	30		