SPSS Practical Manual on Factorial Experiments

Legend:
$\mu = 0, \quad \sigma^2 = 0.2,$
$\mu = 0, \quad \sigma^2 = 1.0,$
$\mu = 0, \quad \sigma^2 = 5.0,$
$\mu = -2, \ \sigma^2 = 0.5,$

Vertical axis: $\varphi_{\mu,\sigma^2}(x)$

Horizontal axis: x

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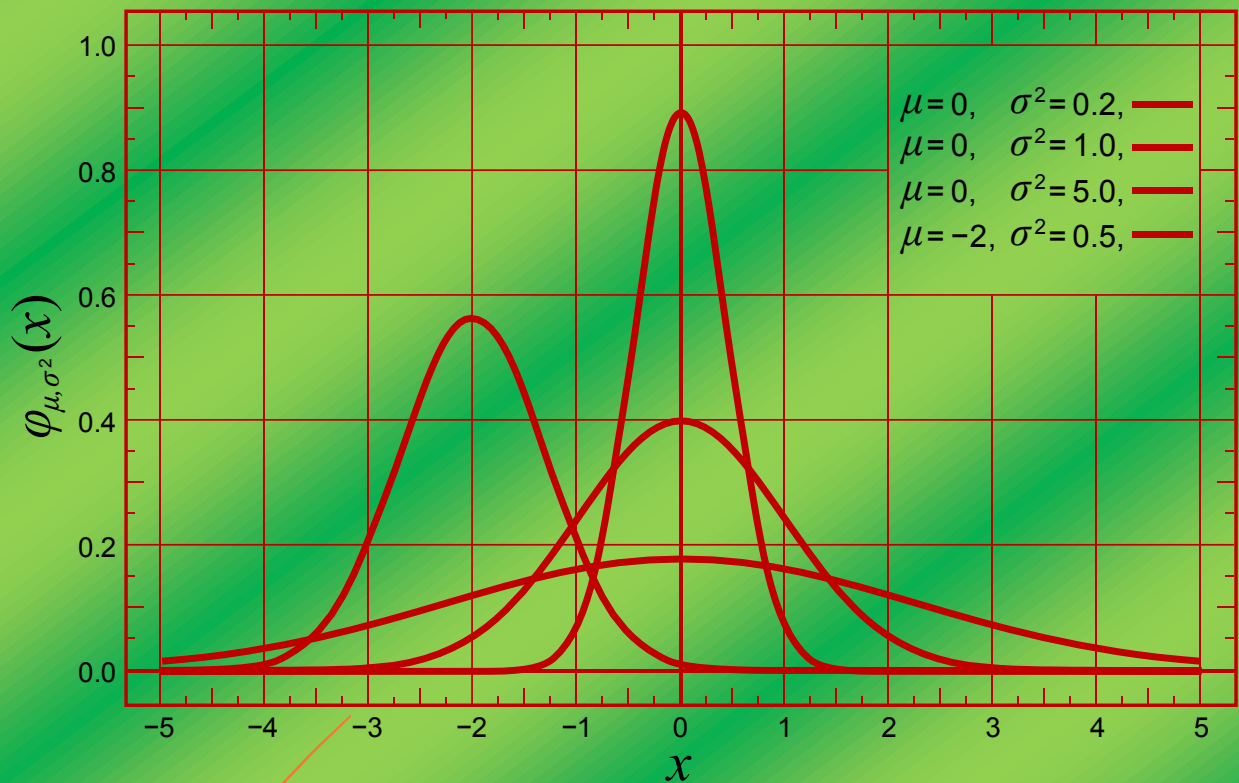Institute of Agriculture, Visva-Bharati, Sriniketan
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Example:

The yields of wheat (C-591), in lbs per plot, under the various treatment combinations in the randomized block design carried out at a research station are given below. There were three sowing dates S1, S2 and S3, which may be regarded as three levels of the factor, S and four levels of the factor N or doses of Nitrogen namely. There were, thus 3×4 or 12 treatment combination tested in a randomized block design with six replications.

Identify the design, analyze the data and draw your conclusion.

Factor	Level	Coded Level
	First	S_1
Sowing Dates (S)	Second	S_2
	Third	S_3
	0 lbs. (Control)	N_0
Doses of Nitrogen (N)	30 lbs.	N_1
	60 lbs.	N_2
	90 lbs.	N_3

Mathematical Model:

$$y_{ijk} = \mu + b_i + \alpha_j + \beta_k + \delta_{jk} + \varepsilon_{ijk}$$

Yield = μ + Replication + Factor A + Factor B + Interaction (A×B) + ε_{ijk}

where

y_{ijk} = Response from the ith block for jth level of A and kth level of B
μ = inherent response (General effect)
b_i = Effect of ith replication (blocks)
α_j = Effect of jth level of factor A
β_k = Effect of kth level of factor B
δ_{jk} = Interaction between jth level of A and kth level of B
ε_{ijk} = Error associated with y_{ijk}
$j=1, 2, \ldots, p; \quad k=1, 2, \ldots, q$

Treatment combinations	R1	R2	R3
S_1N_0	8.30	10.30	8.00
$S_1 N_1$	9.30	9.00	9.50
$S_1 N_2$	11.30	11.50	11.30
$S_1 N_3$	10.50	15.70	10.50
$S_2 N_0$	5.70	4.50	8.30
$S_2 N_1$	4.70	5.30	8.00
$S_2 N_2$	5.30	5.50	8.00
$S_2 N_3$	6.50	8.30	8.00
$S_3 N_0$	5.00	4.70	1.50
$S_3 N_1$	7.00	8.30	2.50
$S_3 N_2$	3.30	3.30	2.50
$S_3 N_3$	2.70	4.30	1.30

Step 1: Arrange the Data for analysis in this way:

Rep	S	N	Yield
1	1	0	8.30
1	1	1	9.30
1	1	2	11.30
1	1	3	10.50
1	2	0	5.70
1	2	1	4.70
1	2	2	5.30
1	2	3	6.50
1	3	0	5.00
1	3	1	7.00
1	3	2	3.30
1	3	3	2.70
2	1	0	10.30
2	1	1	9.00
2	1	2	11.50
2	1	3	15.70
2	2	0	4.50

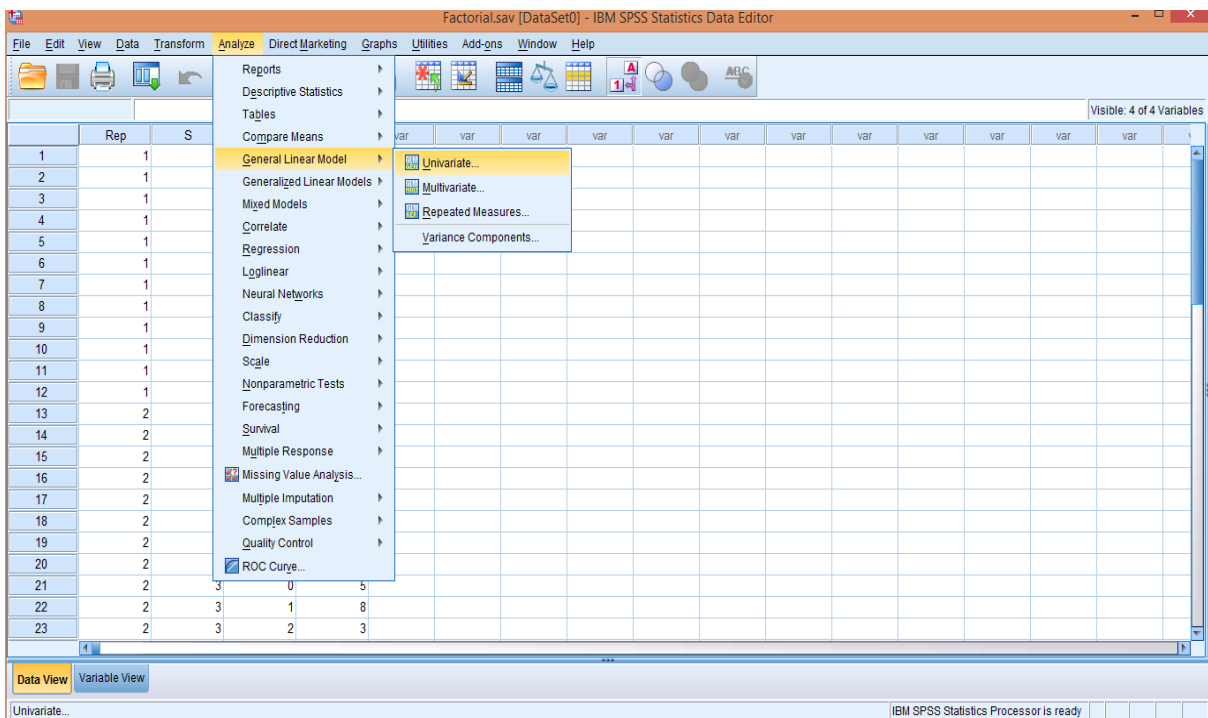|			
2	2	1	5.30
2	2	2	5.50
2	2	3	8.30
2	3	0	4.70
2	3	1	8.30
2	3	2	3.30
2	3	3	4.30
3	1	0	8.00
3	1	1	9.50
3	1	2	11.30
3	1	3	10.50
3	2	0	8.30
3	2	1	8.00
3	2	2	8.00
3	2	3	8.00
3	3	0	1.50
3	3	1	2.50
3	3	2	2.50
3	3	3	1.30

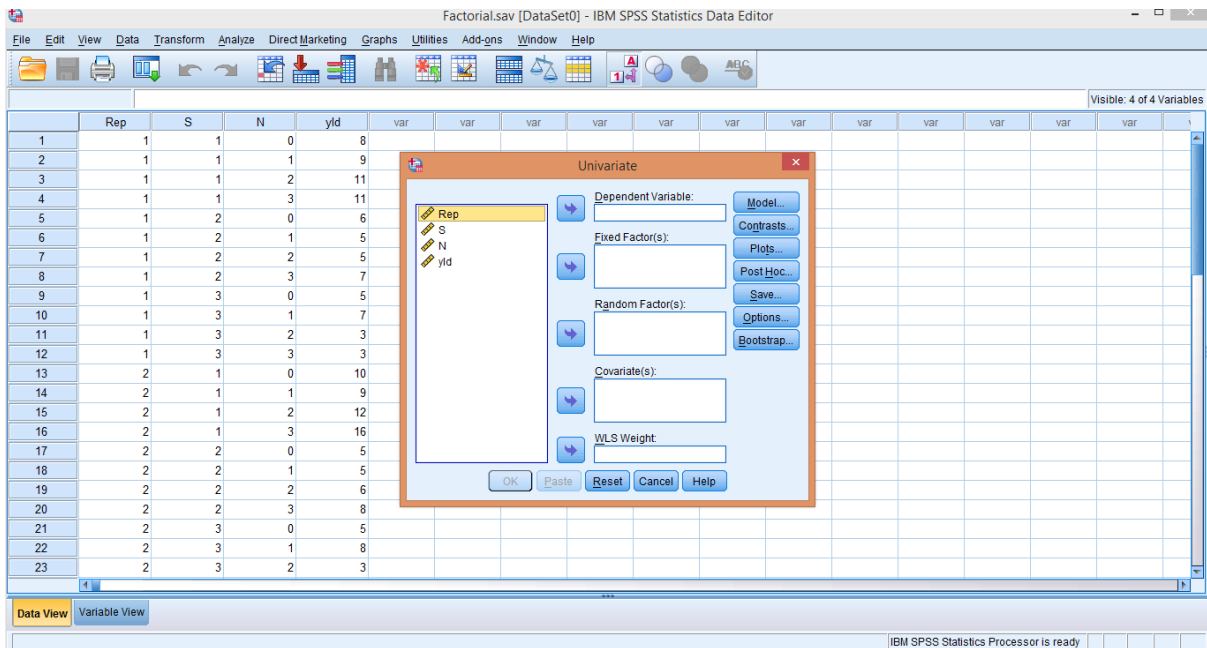Step 2: Start → All Programs → All Programs → SPSS
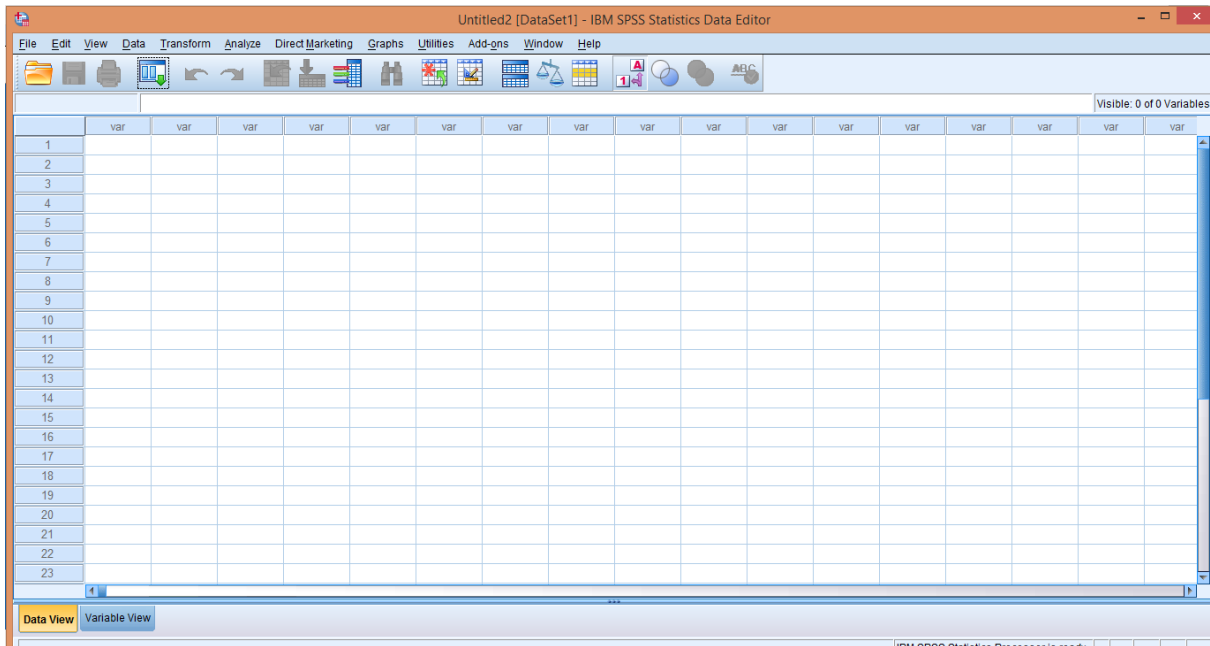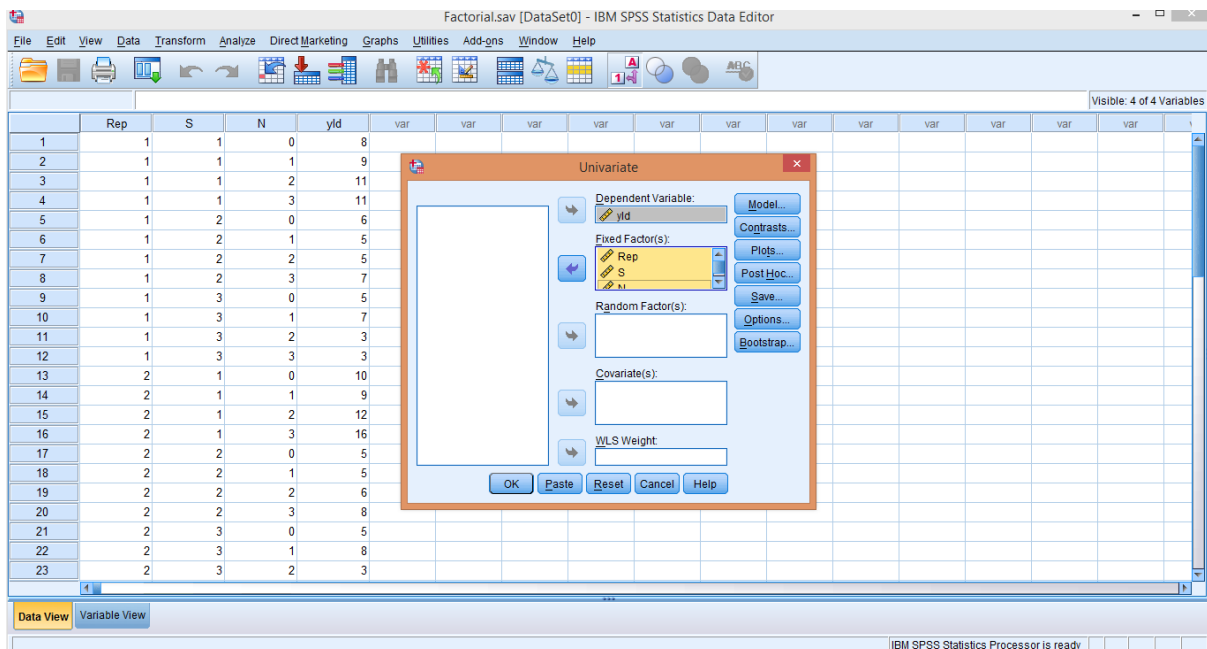
Step 3: Enter data in SPSS Data Editor
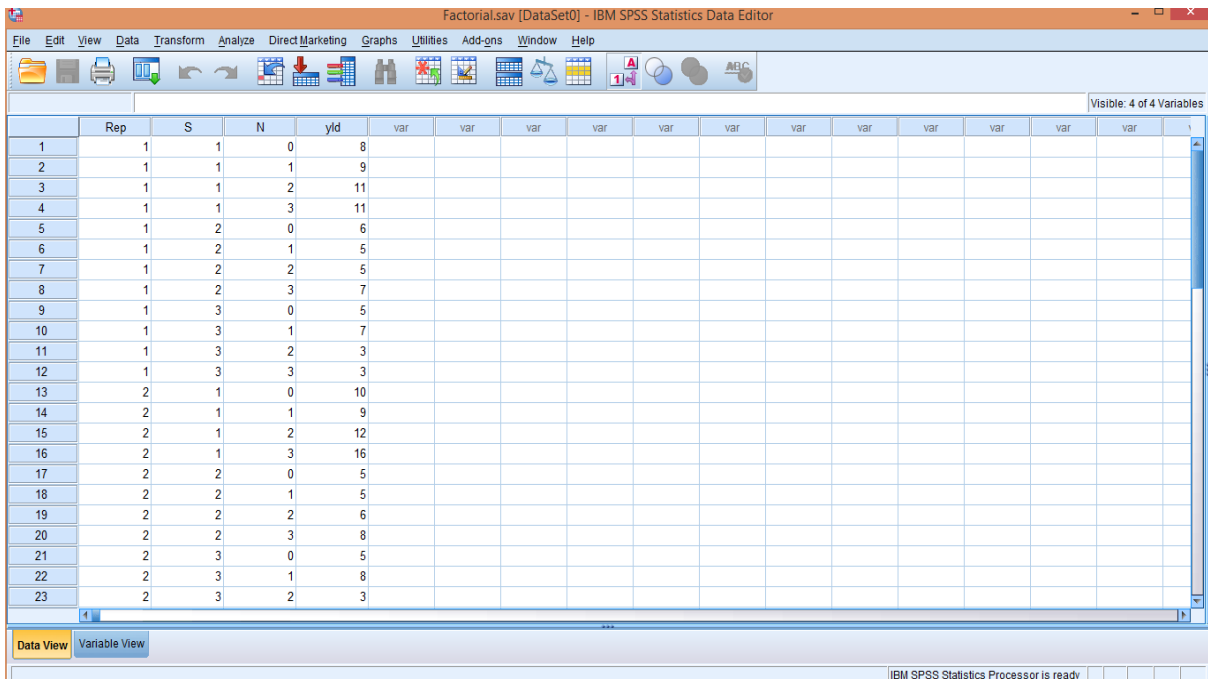
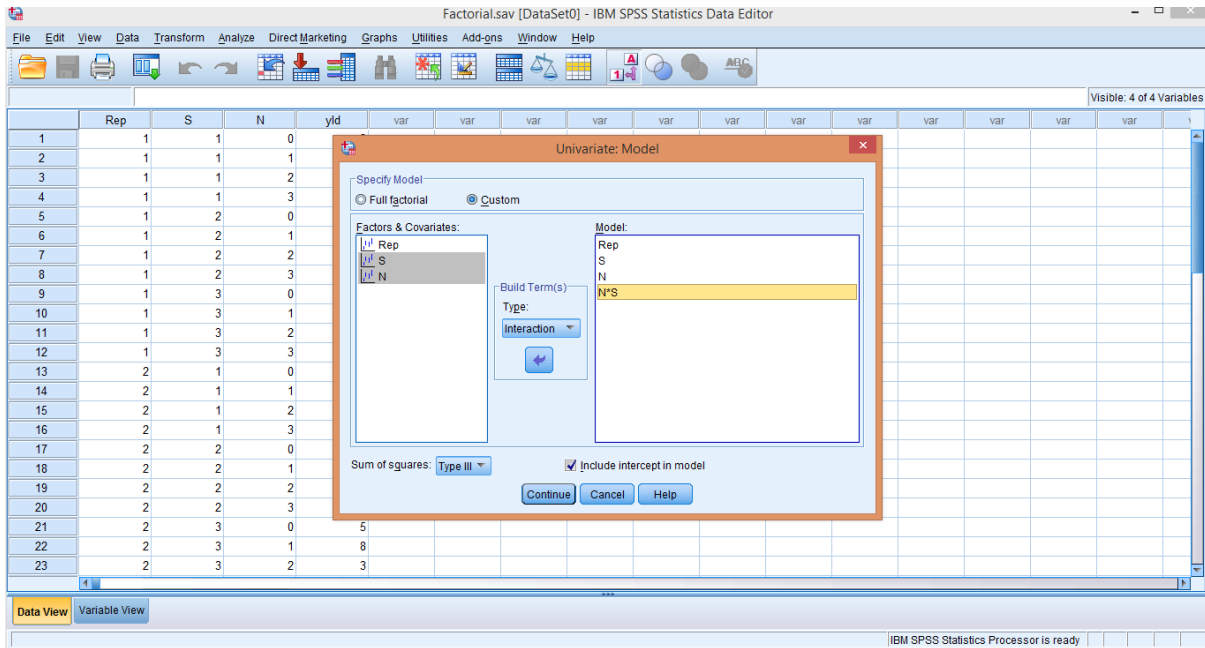**Step 4:** Analyze → General Linear Model → Univariate.

Step 5: Select yld and send it to the Dependent Variable box; Rep, S and N may be selected and assigned in Fixed Factor(s) box.

Step 6: Model → Custom → select Main effect →Put Rep, S, N into model box → select Interaction→ S×N to Model → continue

Step 7: Univariate → Post Hoc → select Factors S, N →Post Hoc Test → Duncan → continue → OK

Output:

Tests of Between-Subjects Effects

Dependent Variable: yld

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	316.227ª	13	24.325	8.178	.000
Intercept	1731.947	1	1731.947	582.291	.000
Rep	6.971	2	3.485	1.172	.328
S	262.021	2	131.010	44.046	.000
N	7.552	3	2.517	.846	.483
S * N	39.684	6	6.614	2.224	.079
Error	65.436	22	2.974		
Total	2113.610	36			
Corrected Total	381.663	35			

a. R Squared = .829 (Adjusted R Squared = .727)

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Post Hoc Tests:

S -Homogeneous Subsets

yld

Duncan

S	N	Subset		
		1	2	3
3	12	3.87		
2	12		6.51	
1	12			10.43
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square (Error) = 2.974.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

N-Homogeneous Subsets

Yld

Duncan

N	N	Subset
		1
0	9	6.26
2	9	6.89
1	9	7.07
3	9	7.53
Sig.		.163

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 2.974.

a. Uses Harmonic Mean Sample Size = 9.000.

b. Alpha = 0.05.

Do Yourself

An experiment was conducted at Ludhiana center on cropping system using a factorial experiment with two factors viz., N-Nitrogen (0, 25, 50 and 75 kg/ha), P-Phosphorous (0, 15 and 30 kg/ha). These 12 treatment combinations were arranged in three replications. Analyze the data and draw your conclusion.

	R1	R2	R3
N_0P_0	10.70	11.20	11.00
N_0P_{15}	24.60	25.00	27.70
N_0P_{30}	24.00	23.30	23.70
$N_{25}P_0$	19.70	20.00	19.60
$N_{25}P_{15}$	23.00	23.10	22.70
$N_{25}P_{30}$	14.60	15.00	14.70
$N_{50}P_0$	18.00	18.10	17.70
$N_{50}P_{15}$	20.70	21.00	20.60
$N_{50}P_{30}$	10.70	11.00	10.60
$N_{75}P_0$	19.60	20.00	19.70
$N_{75}P_{15}$	17.70	19.10	18.00
$N_{75}P_{30}$	10.70	11.20	11.00
Total	214.00	218.00	217.00

Reference Books:

1. A Hand Book of Agricultural Statistics, S. R. S. Chandel, Achal Prakashan Mandir, Kanpur.
2. A Text book of Agricultural Statistics, R. Rangaswamy, New Age International (P) Limited, publishers.
3. Biometrical Methods in Quantitative Genetic Analysis, R.K. Singh and B. D. Chaudhary, Kalyani Publishers.
4. Design Resources Server: www.iasri.res.in
5. E-Manual Winter School IASRI.
6. Fundamentals of Mathematical Statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons Educational Publications.
7. Fundamentals Applied Statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons Educational Publications.
8. Programmed Statistics, B.L. Agarwal, New Age International (P) Limited, publishers.
9. Probability and Statistical Inference Theory and Practice, D. Bhattacharya and S. Roy Chowdhury, U. N. Dhur & Sons.
10. Statistics Theory and Practice, D. Bhattacharya and S. Roy Chowdhury, U. N. Dhur & Sons.
11. Statistical Methods, K.P. Dhamu and K. Ramamoorthy, AGROBIOS (INDIA)
12. Statistics for Agricultural Sciences, G. Nageswara Rao, Second Edition, BS Publications, Hyderabad.