

## Influence of Nitrogen application on yield and net returns of high yielding varieties of Rice

by

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The 'new strategy' in agricultural development consists in the cultivation of high yielding varieties of rice. The newly introduced rice varieties, IR-8, Padma and GS-351 have created much interest throughout India. N is one of the most important factors in increasing the yield of these varieties of rice. Specific knowledge of their response of yield to N is essential for two reasons. Firstly, in food deficit country like India, it may be the objective of national policy to maximise the yield of food grains/ha irrespective of the cost of fertilizer. Secondly, in view of the limited supply of fertilizers available and its high cost, it is essential to have a clear understanding of the response to crop yields as well as net return from crops at various levels of fertilizer application. In this present investigation, attempt has been made to study (1) response of varieties to various levels of N, (2) to determine the most profitable level of N and (3) comparing the total cost, total revenue and net profit due to application of N on the high yielding varieties of rice.

**Materials and methods** - The data for this study were obtained from the fertilizer experiments conducted in the Punjab Agricultural University on dwarf rice varieties. Alongwith, the tall Indian high yielding rice variety GS-351 was also studied. There were five N levels (0, 50, 100, 150 and 200 kg N/ha) for Padma and IR-8 and five levels viz; 0, 40, 80, 120 and 180 kg N/ha for GS-351 and Taichung Native-1. (T.N.1) Response to N was estimated from the pooled data (1968 and 1969) by fitting quadratic production functions. For estimating cost and returns, N per kg was valued at Rs. 2.70 and rice @ Rs. 55/- per quintal. Total revenue, total cost, net profits and response to N shown in Tables 1, 2, 3 were incident to the application of N.

**Results:** Per hectare total yields (Ye) for respective levels of N application were estimated by fitting quadratic production functions in each case with the following results:—

$$\text{GS-351 : } Y_e = 1666.52 + 17.445 N - 0.07428 N^2; \quad R^2 = 0.98$$

$$\text{IR-8 : } Y_e = 2746.00 + 14.960 N - 0.04480 N^2; \quad R^2 = 0.98$$

$$\text{Padma : } Y_e = 3178.60 + 21.852 N - 0.06094 N^2; \quad R^2 = 0.98$$

$$\text{TN1 : } Y_e = 1767.76 + 33.350 N - 0.12169 N^2; \quad R^2 = 0.99$$

Rice yield responses (Yr) due to N application for each variety were estimated by fitting the following production functions: GS-351:  $Y_r = 17.445 N - 0.07428 N^2$ , IR-8:  $Y_r = 14.960 N - 0.04480 N^2$ , Padma:  $Y_r = 21.852 N - 0.06094 N^2$ , TN-1:  $Y_r = 33.350 N - 0.12169 N^2$

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TABLE 1. Yield of rice varieties at different levels of nitrogen application

Nitrogen kg/ha	Yield in kg/ha			
	G.S. 351	IR-8	Padma	TN-1
1	1666.52	2746.00	3178.00	1767.76
25	2056.22	3070.80	3687.08	2525.46
50	2353.07	3382.00	4119.15	3131.04
75	2557.07	3577.32	4475.02	3584.51
100	2668.22	3794.00	4754.70	3885.86
125	2686.52	3916.00	4958.22	4035.11
150	2611.97	3982.00	5085.55	4032.24
175	2444.57	3992.00	5136.72	3877.26
200	2184.12	3946.00	5111.17	3570.16

Table 1 shows that the dwarf varieties (IR-8, Padma and TN.1) gave relatively more response to N at higher levels of application than the tall variety, GS-351. The difference in yield response increased still more at higher rates of N application. However, to the first dose of N application, the tall variety, GS-351 gave moderate response, its yield without N application was 1666.52 kg/ha being lower to all dwarf varieties. The maximum rice production / ha was obtained from Padma and TN.1 at 179.29 kg N and 137.02 N/ha respectively.

*Optimal or most profitable level of N:* The most profitable N levels as well as the total revenue and net profit/ha incident to the application of N (Table 2) were calculated on the basis of their revenue and cost functions for each variety. The optimal N levels were much higher for all dwarf rice varieties than for tall GS-351. Tall rice also results in low total income.

Maximum net profit from TN.1 and Padma at 116.85 kg and 139.01 kg N/ha was Rs. 913.98 and Rs. 647.70, respectively. It is clear from Table 2 that the highest net profit was obtained at optimal dose of N application from TN.1 followed by Padma and IR-8 whereas lowest net gain was received from GS-351.

TABLE 2. Yield and net profit per hectare optimal (most profitable) level of nitrogen application

Varieties	Optimal Nitrogen (kg/ha)	Yield (kg/ha)	Total revenue (Rs.)	Total Cost (Rs.)	Net profit (Rs.)
GS-351	84.38	2609.65	518.72	227.82	290.90
IR-8	112.17	3860.39	612.91	302.86	310.05
Padma	139.01	5038.95	1023.03	375.33	647.70
TN-1	116.85	4003.16	1229.47	315.49	913.98

It is clear from Table 2 that the most profitable level of N was about one and half time more for dwarf rice like TN-1, IR-8 and Padma than tall GS-351. In the former cases the total cost and total revenue per hectare were higher than the tall GS-351. Correspondingly the net profit per hectare was also higher for dwarf rice. The N levels giving maximum net returns are lower than the levels giving maximum physical production for all varieties of rice.

*Comparison of optimal & maximum level with the recommended dose:* The total revenue and net profit incident to N application at all maximum level and recommended dose are shown in Table 3. At maximum level and recommended dose, TN-1 gave the maximum net profit followed by Padma. Tall variety GS-351 gave lowest net profit at maximum level and recommended dose.

TABLE 3. *Yield and net profit at maximum level and recommended dose of N application (kg/ha)*

Varieties	Recommended dose <sup>1</sup>			Maximum level <sup>2</sup>		
	Yield (kg/ha)	Total revenue (Rs.)	Net profit (Rs.)	Yield (kg/ha)	Total revenue (Rs.)	Net profit (Rs.)
GS-351	2445.82	428.61	266.61	2690.72	563.31	246.28
IR-8	3982.00	679.80	274.80	3994.90	686.89	236.10
Padma	5085.55	1048.66	643.66	5137.83	1077.41	593.33
TN-1	4032.24	1245.46	840.46	4052.71	1256.72	866.77

1. Recommended dose for GS-351, is 60 kg N/ha, and for IR-8, Padma and Taichung Native-1 is 150 kg N/ha for each (from package practices for kharif crops of Punjab, Haryana and Himachal Pradesh 1968-69, Punjab Agricultural University, Ludhiana).
2. Maximum level for GS-351, IR-8, Padma and TN-1 were 117.42, 166.96, 179.29 and 137.02 kg N/ha respectively.

A comparative study of Tables 2 and 3 clearly indicates that all the three dwarf rice varieties and tall GS-351 gave more net profit at optimal or most profitable level of N application. These varieties also excelled at recommended dose and maximum level with exception of TN-1 which gave more net gain at maximum level of N application.

TABLE 4. *Yield and net profit per kg of nitrogen application at optimal level, maximum level and recommended dose*

Varieties	Optimal level		Maximum level		Recommended dose	
	Yield (kg)	Net profit (Rs.)	Yield (kg)	Net profit (Rs.)	Yield (kg)	Net profit (Rs.)
GS-351	11.17	3.44	8.72	2.09	12.98	4.44
IR-8	9.93	2.76	7.48	1.41	8.24	1.83
Padma	13.38	4.65	10.92	3.30	12.71	4.29
TN-1	19.13	7.81	16.67	6.47	15.09	5.60

Response of yield to N per kg and N/ha shown in Table 4 clearly depicts that tall GS-351 gave more grain yield and net profit at recommended dose followed by optimum and maximum levels, whereas IR-8 and Padma gave highest at optimum level followed by recommended and maximum levels. TN-1 resulted in highest at optimum followed by maximum and recommended doses in respect of grain yield and net profit per kg N application. Highest response to grain yield and net profit was obtained from TN-1 followed by Padma and lowest was received from IR-8.

**Conclusion :** This study showed that TN-1 and Padma were highly responsive to higher levels of N followed by IR-8 and GS-351. The per hectare maximum level of N applications giving maximum production response to N were 179.29 kg and 137.02 kg for Padma and TN-1 respectively. The most profitable level of N application for TN-1 and Padma were 116.85 kg and 139.01 kg/ha respectively. Net profit due to N application at the most profitable levels were respectively Rs. 913.98 and Rs. 647.70 per hectare from TN-1 and Padma as compared to Rs. 290.90 per hectare from tall GS-351 variety.

GS-351	179.29	137.02	116.85	139.01
IR-8	179.29	137.02	116.85	139.01
Padma	179.29	137.02	116.85	139.01
TN-1	179.29	137.02	116.85	139.01

Recommended dose for GS-351 is 60 kg N/ha and for IR-8, Padma and Taining Native-1 is 140 kg N/ha for each (from package practices for kharif crops of Punjab, Haryana and Himachal Pradesh 1962-63, Punjab Agricultural University, Ludhiana).

Maximum level for GS-351, IR-8, Padma and TN-1 were 117.17, 166.96, 179.29 and 177.00 kg N/ha respectively.

A comparative study of Tables 2 and 3 clearly indicates that all the three dwarf rice varieties and tall GS-351 gave more net profit at optimal or most profitable level of N application. These varieties also excelled at recommended dose and maximum level with exception of TN-1 which gave more net gain at maximum level of N application.

TABLE 4. Yield and net profit per kg of nitrogen application at optimum level, maximum level and recommended dose

Varieties	Optimal level		Maximum level		Recommended dose	
	Yield (kg)	Net profit (Rs.)	Yield (kg)	Net profit (Rs.)	Yield (kg)	Net profit (Rs.)
GS-351	11.17	3.41	8.75	2.09	12.98	4.14
IR-8	9.93	2.76	7.48	1.41	8.24	1.93
Padma	11.32	4.63	10.92	3.30	12.71	4.39
TN-1	10.13	7.81	16.67	6.47	12.09	2.60