

The Influence of Different Forms of Nitrogen on the Growth and Yield Characters of Some Kerala Rice Varieties*

K. KOCHAPPAN NAIR¹ AND M. M. KOSHY²

Division of Chemistry, Agricultural College & Research Institute, Vellayani

Received for publication August 6, 1966

Numerous experiments conducted all over the world on a wide variety of soils and under different climatic conditions indicate that rice responds excellently to applications of nitrogen. The extent of response, however, varies with the form of nitrogen and the variety of rice. Chang et al (1953) studied the relative availability of ammonium sulphate, ammonium chloride, ammonium nitrate and urea to rice. They found that ammonium sulphate and ammonium chloride were more effective than urea, ammonium nitrate being the least effective. Ling and Wang (1956) investigated the relative availability of ammonium sulphate, ammonium chloride, calcium, ammonium nitrate and urea to rice and found that there was no significant difference between ammonium sulphate and ammonium chloride, both being more effective than urea. Calcium ammonium nitrate was the least effective. Summarising the results of a large number of field experiments on the efficacy of different nitrogenous fertilisers, Abichandani and Patnaik (1958) concluded that ammonium fertilisers were far superior to nitrate fertilisers for increasing yields. Reviewing the use of commercial

fertilisers in India, Raychaudhuri (1960) has reported on the relative efficiencies of ammonium chloride, ammonium sulphate, urea and ammonium nitrate applied at the rate of 20 lb N per acre on paddy (variety T. 1145) at Cuttack. The responses in yield per pound of nitrogen were 24.7, 21.3, 17.1 and 16.4 lb rice respectively for ammonium chloride, ammonium sulphate, urea and ammonium nitrate. As regards the influence of variety on nitrogen utilisation Grist (1953) concluded that the yield of rice in countries where japonica varieties were grown was higher than that of countries growing indica varieties. This has been borne out by the investigations of Tanaka et al (1958) in India who found that the japonica varieties utilised nitrogen more efficiently under high manuring conditions and gave better yield.

A number of improved varieties of rice have lately become popular with farmers in Kerala. However, very little information is available regarding the effect of different forms of nitrogen on the growth characters and yield of these varieties. Hence the present investigation was undertaken with a

* Condensed from the thesis submitted by K. Kochappan Nair to the university of Kerala in partial fulfilment of the requirements for the M. Sc. (Agri) degree, 1964. Published by kind permission of the University of Kerala, Trivandrum.

1. Present address: Research Assistant, Rubber Research Institute, Kottayam.
2. Additional Professor of Chemistry and Agricultural Chemist.

view to studying the influence of different nitrogenous fertilisers on the growth and yield characters of some of the rice varieties popular in this State,

Materials and Methods

The effect of four forms of nitrogen on four varieties of rice was studied in a pot culture experiment using a 4 x 4 x 3 randomized block design. The fertilisers used were, ammonium sulphate, ammonium nitrate, ammonium chloride and urea at the

rate of 40 kg N/ha. The rice varieties studied were Ptb 10, Ptb 12, Ptb 20 and Ptb 21. The more important of the genetic characters of these varieties are given in Table I. The soil used in the experiment was a sandy loam collected from the unmanured area of the College Paddy Farm. Chemical analysis showed that this soil was well supplied with phosphorus (0.13% P_2O_5), but low in all the other plant food elements. (0.02% N, 0.06% K_2O , 0.03% CaO and 0.04% MgO)

TABLE I

Description of the rice varieties used in the experiment

	Ptb 10	Ptb 12	Ptb 20	Ptb 21
Local name	<i>Thekkan cheera</i>	<i>Chitteri</i>	<i>Vadakkan</i>	<i>Thekkan</i>
Season	Second & third crop	Second crop	Second crop	Second crop
Duration	100 days	130 days	120 days	130 days
Pigmentation	Pigmented	Pigmented	Pigmented	Pigmented
L/B ratio	2.73	2.65	2.76	2.83
Colour of kernel	Red	Red	Red	Red

Forty eight earthenware pots of uniform size with a capacity of 20 kg soil, coated inside with bituminous black was used for the experiment. Sixteen kg of the air-dried and ground soil was weighed into each pot. Lime was applied at the rate of 2000 kg CaO/ha fifteen days before sowing. An additional basal dressing of superphosphate and muriate of potash to supply 45 kg each of P_2O_5 and K_2O were also supplied one day prior to sowing to all the pots. The different forms of nitrogen were supplied at a total rate of 40 kg N/ha. Half the quan-

tity of nitrogen was applied at the time of sowing. All the pots were arranged in the pot culture yard in a randomized manner.

About a dozen selected seeds were sown in each pot. The seeds started germinating in about 3-4 days. Fifteen days after sowing the plants were thinned to keep a stand of four per pot. Controlled irrigation was given to the pots at a uniform rate and optimum moisture conditions were maintained throughout the period of the experiment. The second half of nitrogen was applied to the pots thirty days after sowing

Growth measurements, such as the number of tillers per plant, height of plant etc. were recorded at appropriate stages. At the time of harvest the plants from each pot were separately collected, dried in paper bags in an air-oven at 70°C and the yield of straw and grain recorded.

The growth characters observed were the following :

- (i) The number of tillers per plant as on the 45th day of sowing.
- (ii) The number of effective tillers per plant. This was noted and recorded at the time of harvest. From this the percentage of effective tillers per plant was calculated.
- (iii) Height of plant. This observation was taken one week before harvest.

(iv) Length of earhead.

(v) Number of rachis per earhead.

The yield characters studied were the following :

(i) Number of grains per earhead.

(ii) Yield of grain and straw per pot.

(iii) Grain : Straw ratio.

(iv) Grain : chaff ratio.

(v) The weight of 1000 grains.

Results

(a) Growth characters

Data relating to the effect of different forms of nitrogen on the growth characters of the rice varieties studied are presented in Table II.

TABLE II

Influence of variety and form of nitrogen on the growth characters of rice
(Level of nitrogen: 40 kg/ha)

Variety	Form of nitrogen	Growth character				
		No. of tillers per plant	Effective tillers (percent of total)	Height of plant cm	Length of earhead cm	No. of rachis per earhead
1	2	3	4	5	6	7
Ptb 10	Amm. sulphate	4.25	100.00	83.58	21.05	7.53
	Amm. nitrate	3.25	96.20	84.96	23.08	8.19
	Amm. chloride	2.92	97.90	84.55	20.72	7.76
	Urea	3.75	100.00	82.04	22.40	8.45
	Mean	3.54	98.52	83.76	21.81	8.06
Ptb 12	Amm. sulphate	5.33	97.86	81.96	17.69	8.01
	Amm. nitrate	7.08	98.72	81.00	18.41	8.81
	Amm. chloride	6.33	94.99	80.20	18.53	8.51
	Urea	4.58	96.68	81.63	18.56	8.60
	Mean	5.83	97.06	81.20	18.29	8.46

1	2	3	4	5	6	7
Ptb 20	Amm. sulphate	6.25	93.88	89.75	21.44	8.49
	Amm. nitrate	4.83	98.41	89.16	17.33	8.15
	Amm. chloride	7.25	96.96	93.85	17.08	7.58
	Urea	5.00	95.38	89.91	18.58	8.48
	Mean	5.83	96.16	90.67	18.61	8.18
Ptb 21	Amm. sulphate	6.33	98.85	95.48	19.15	8.04
	Amm. nitrate	4.92	97.85	84.37	17.76	7.70
	Amm. chloride	5.33	94.03	89.55	17.49	6.99
	Urea	5.08	97.59	89.79	18.09	7.87
	Mean	5.41	98.08	89.80	18.12	7.65
All varieties	Amm. sulphate	5.54	97.65	87.69	19.83	8.10
	Amm. nitrate	5.02	97.79	84.87	19.14	8.21
	Amm. chloride	5.45	95.97	87.04	18.46	7.71
	Urea	4.60	97.41	85.84	19.41	8.35
Critical difference at 5 percent level		0.846	..	3.512	1.227	0.494

As regards the number of tillers produced, the varieties exhibit significant differences. Variety Ptb 12 produced the largest number of tillers per plant (5.83) and Ptb 10 the lowest (3.54), the other two varieties giving intermediate results. The number of effective tillers was, however, not influenced significantly either by variety or form of nitrogen used. The height of plants was primarily a varietal character which was little influenced by form of nitrogen. The maximum height was attained by Ptb 20 (90.7 cm) and the minimum by Ptb 12 (81.1 cm). The length of earhead and the number of rachis per earhead were also varietal characters which were not significantly affected by nitrogen treatments. The maximum length of earheads was for the variety Ptb 10 (21.8 cm) and

the minimum for Ptb 21 (18.1 cm). Variety Ptb 12 had the largest number of rachis per earhead (8.4) and Ptb 21 the lowest (7.6)

(b) Yield characters

Results relating to the effect of different forms of nitrogen on the yield characters of rice are given in Table III.

The number of grains per earhead varied considerably with the form of nitrogen used, ammonium sulphate and ammonium chloride being superior to urea and ammonium nitrate. The largest number of grains per earhead was produced by ammonium sulphate (39.8) and the lowest number by ammonium nitrate (32.3)

In the matter of total yield the varieties Ptb 20 and Ptb 12 were superior to Ptb 21 and Ptb 10. The highest yield was recorded

TABLE III

Influence of variety and form of nitrogen on the yield characters of rice

(Level of nitrogen : 40 kg/ha)

Variety	Form of nitrogen	Yield character					
		No. of grains per earhead	Grain : chaff ratio	Wt. of straw g/pot	Wt. of grain g/pot	Grain : straw ratio	Weight of 1000 grains g
Ptb 10	Amm: sulphate	40.8	4.1	39.55	28.22	1.39	22.67
	Amm: nitrate	33.2	4.5	29.75	24.07	1.29	23.41
	Amm: chloride	38.0	4.5	27.71	24.27	1.12	23.42
	Urea	41.8	4.3	35.79	26.77	1.34	23.22
	Mean	38.4	4.4	33.20	25.85	1.28	23.18
Ptb 12	Amm: sulphate	39.1	4.3	34.40	39.51	0.91	26.74
	Amm: nitrate	35.8	4.2	39.05	45.66	0.87	26.29
	Amm: chloride	37.9	4.4	36.36	40.33	0.90	27.36
	Urea	32.1	4.6	27.73	28.91	0.96	26.95
	Mean	36.2	4.4	34.36	38.60	0.91	26.83
Ptb 20	Amm: sulphate	41.4	4.1	39.08	42.20	0.93	27.42
	Amm: nitrate	31.8	4.8	25.11	34.66	0.73	25.47
	Amm: chloride	45.4	4.1	40.90	47.00	0.86	25.42
	Urea	34.8	4.5	28.32	32.33	0.88	25.32
	Mean	38.3	4.3	33.35	39.05	0.85	25.91
Ptb 21	Amm: sulphate	38.3	4.1	37.49	52.00	0.73	26.25
	Amm: nitrate	28.7	4.8	19.76	39.66	0.50	25.33
	Amm: chloride	36.5	4.5	28.63	50.66	0.58	24.79
	Urea	31.7	4.6	34.37	48.33	0.61	24.46
	Mean	33.8	4.5	27.56	45.66	0.62	25.26
All varieties	Amm: sulphate	39.9	4.1	37.63	40.50	0.98	25.77
	Amm: nitrate	32.3	4.6	28.42	36.01	0.85	25.18
	Amm: chloride	39.4	4.3	33.40	40.57	0.86	25.25
	Urea	35.1	4.5	29.05	32.06	0.74	24.99
Critical difference at 5 percent level		3.99	0.22	4.82	6.28	0.07	0.58

for Ptb 12 (34.4 g/pot) and the lowest for Ptb 21 (27.5 g/pot). The form of nitrogen had very little influence on the yield of grain. However, ammonium sulphate tended to be superior to the other forms of nitrogen in this respect. This fertiliser gave the highest yield (33.6 g/pot) and urea the lowest (29.0 g/pot), ammonium chloride and urea producing intermediate results. The grain : chaff ratio was highest for the variety Ptb 21 (4.5) and the lowest for Ptb 20 (4.3)

The yield of straw varied considerably with variety and form of nitrogen. The highest yield of straw was recorded for Ptb 21 (45.6 g/pot) and the lowest for Ptb 10 (25.8 g/pot) Variety Ptb 21 was statistically superior to the other varieties in this respect. As regards the effect of form of nitrogen on this character ammonium chloride produced the maximum weight of straw per pot (40.57 g) closely followed by ammonium sulphate (40.50 g). Urea gave the lowest yield of straw per pot, viz., 32.06 g.

The grain: straw ratio was influenced by variety and form of nitrogen and the results were highly significant. Variety Ptb 10 gave the maximum value for this character (1.2) and Ptb 21 the lowest (0.6). Of the different fertilisers used ammonium sulphate gave the maximum ratio (0.9) and ammonium nitrate the minimum (0.8)

The weight of 1000 grains was found to be a varietal character, which was little affected by the form of nitrogen used. The maximum weight of 1000 grains was recorded for the variety Ptb 12 (26.8 g) and the minimum for Ptb 10 (23.1 g) Variety Ptb 12 was superior to Ptb 20 and Ptb 21 in this respect, while Ptb 10 was inferior to all the others.

Discussion

The results of the present study indicate that many of the growth and yield characters of rice are largely dependent on variety and that the different forms of nitrogen influence them only to small extents. The number of tillers per plant, the plant height, length of earhead and the number of rachis per earhead are all primarily varietal characters. The total yield of grain and straw, as well as the grain : chaff ratio, also varies significantly with variety. As regards the efficacy of different forms of nitrogen it is noted that ammonium sulphate gave the maximum yield and ammonium nitrate the minimum. But the effect of form of nitrogen on grain yield has not been statistically significant. The trend, however, agrees with the general observation that ammoniacal nitrogen is more effective than the nitrate form for rice. (Sethi *et al*, 1952; Grist, 1953; Bisset and Andrew, 1953 and Abichandani and Patnaik, 1958) According to Raychaudhuri (1960) ammonium chloride is the most efficient form of nitrogenous fertiliser for rice as compared to ammonium sulphate, urea and ammonium nitrate. Ammonium chloride has the advantage that it contains nitrogen in the ammoniacal form, and at the same time, it is not subject to sulphide toxicity. The low yields given by ammonium nitrate might be due to the chemical changes, as for instance the formation of nitrite, undergone by this fertiliser under the anaerobic conditions prevailing in submerged soils.

Summary and Conclusions

A pot culture experiment in a 4² x 3 randomised block design was carried out to study the influence of different forms of nitrogenous fertilisers on the growth and yield characters of four rice varieties of Kerala. The fertilisers used were am-

monium sulphate, ammonium nitrate ammonium chloride & urea at the rate of 40 kg N/ha. The rice varieties were Ptb 10, Ptb 12, Ptb 20 and Ptb 21. The results are summarised below:

1. Of the growth characters studied, the number of tillers per plant, the plant height, length of earhead and the number of rachis per earhead varied significantly with variety. Variety Ptb 12 had the largest number of tillers per plant and rachis per earhead. Ptb 20 attained the maximum height and Ptb 10 produced the longest earheads.
2. Form of nitrogen had no significant effect on any of the growth characters studied.
3. Of the different yield characters studied, variety influenced the total yield of grain, the grain : chaff ratio and weight of 1000 grains. Variety Ptb 12 gave the highest yield and maximum thousand grain weight- Ptb 21 showed the highest grain : chaff ratio and yield of straw, while Ptb 10 gave the maximum grain : straw ratio.
4. The number of grains per earhead was influenced by the form of nitrogen used. Ammonium sulphate produced the largest number of grains per earhead and ammonium nitrate the lowest. Though the yield of grain was not significantly influenced by the form of nitrogen, ammonium sulphate tended to be superior to the other forms in this respect, followed by ammonium chloride, ammonium nitrate and urea.

Acknowledgement

The authors are deeply indebted to Dr. C. K. N. Nair, Principal and Additional

Director of Agriculture (Research), Agricultural College & Research Institute, Vellayani, for providing all the facilities for this work.

References

1. Abichandani C. T. and Patnaik, S. (1958) Nitrogenous fertilizer for rice., Ammonium or Nitrate from. *Rice News Teller*, 6 (2) : 8-12.
2. Bissett, W. J. and Andrew, C. S. (1953) The effect of nitrogen on the yield, nitrogen content, and baking quality of wheat grown on the Darling Downes, Queensland. *J. Aust. Agric. Sci.* 19 : 40-44
3. Chang, S. C., Tseng, H. D. and Huang, K. S. (1953) A study of the relative availability of ammonium sulphate, ammonium chloride, ammonium nitrate and urea to rice. *Agric. Res. Taiwan*, 4 (2) : 1-41.
4. Grist, D. H. (1953) *Rice*. Longmans Green & Co., London.
5. Ling, K. C. and Wang, C. Y. (1956) The relative availability of ammonium sulphate, ammonium chloride, calcium ammonium nitrate and urea to rice. *Agric. Res. Taiwan*, 6 : 23-39.
6. Raychaudhuri, S. P. (1960) *Use of artificial fertilisers in India*, I. C. A. R., New Delhi.
7. Sethi, R. L., Ramiah, K. and Abraham, T. P. (1952) *Manuring of rice in India*. I. C. A. R., New Delhi.
8. Tanaka, A. Patnaik, S. & Abichandani, C. T. (1958) Studies on the nutrition of rice plant. II. A comparative study of the nitrogen requirements of indica and japonica varieties of rice. *Proc. Ind. Acad. Sci.* 48 (B) • 14-27.