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Relative Merits of Chilean Nitrate and Ammonium Sulphate as Manure for Rice in South Kanara

by

K. BALAKRISHNA RAO,
K. V. AHAMED BAVAPPA and K. HANUMANTHA ROW
Paddy Breeding Station, Mangalore

Introduction : The presence of an adequate supply of available nitrogen in the soil is one of the most important factors relating to maintenance or improvement of soil fertility. The lack of sufficient nitrogen in soils, particularly those that have been cropped for many years has long been a limiting factor in crop production. Of all the nutrients, rice has responded to the maximum extent to nitrogen application in one from or other in all the rice growing tracts of the world. Green leaf, cattle manure and oilcakes are some of the important organic nitrogenous manures used for rice. But among the inorganic nitrogenous manures ammonium sulphate is the most commonly used fertilizer.

The effect of ammonium sulphate on acid soils tending to increase the soil acidity particularly if used continuously is likely to bring in limitations in crop production in the long run. If the acidity of the soil becomes too great, harmful compounds, chiefly of aluminium may go into solution, resulting frequently in what is termed as aluminium toxicity. Besides, the availability of phosphoric acid to plants in such acid soils becomes reduced due to the fixation of phosphoric acid into insoluble compounds of iron and aluminia. It will thus be seen that there is evident need for a nitrogenous fertilizer which in its continued application would not make the soil acidic.

Chilean nitrate (Sodium nitrate) according to the Nitrate Corporation of Chile Limited, London, is a natural fertilizer obtained from the mineral deposits of Northern Chile, its special properties being attributed to the natural blending of plant nutrients. It contains 16% nitrogen in the nitrate from directly assimilable by the roots of plants. It increases the activities of microorganisms in the soil and has therefore special value where conditions of reduced bacterial activity prevail as a result of high temperature. It also conserves soil calcium and prevents acidification thus increasing the

availability of phosphates in the soil. A trial was therefore undertaken to find out how far, on equal nitrogen basis, Chilean nitrate compares with ammonium sulphate as manure for rice in this district where the soils are lateritic and acidic.

The results of the trial carried out at the Paddy Breeding Station, Mangalore, for three years are outlined in this paper.

Literature: Experiments conducted at Woburn showed that application of ammonium sulphate at the rate of two cwts. per acre for several years in succession made the soil absolutely barren, the result being attributed to the acidification of the soil. Rhind and Tin (1948), while growing paddy continuously on the same land for ten years found that 100 lb. per acre per annum of amonium sulphate gave always significantly higher yields than those not treated, but that after the first three years the increase in yield declained from a maximum of 1062 lb. per acre to a minimum of 321 lb. per acre. Ross and Mehring (1938) while discussing the physical and chemical properties of mixed fertilizers say that ammonium sulphate has an acidity of 107 and sodium nitrate an alkalinity of 36 per unit of nitrogen.

In a fifteen year experiment with three five year rotations of corn, oats, rye, wheat and grass, Jacob and Lipman (1917) have proved that sodium nitrate had a manurial value of 100 as against 65 of ammonium sulphate. Small amount of nitrate has also been noted to stimulate the action of Azotobactor. Wyche (1941) has supported the suitability of sodium nitrate as fertiliser for rice under the conditions existing in Taxas. Bartholomew (1929) while discussing the results of the experiment on the availability of nitrogenous fertilizers to rice says that sodium nitrate can be used with good advantage on distinctly acid soils. George Janssen and Metzgen (1928) have proved that rice undoubtedly drew upon the nitrate of the soil under non-submerged conditions. The cost of one pound of nitrogen in both ammonium sulphate as well as in chilean nitrate are almost the same (Sanyasi Raju 1952).

Materials and Methods: A randomized replicated experiment with ammonium sulphate and chilean nitrate applied at two levels of nitrogen 40 lb. and 60 lb. per acre, alone and over a basal dressing which consisted of 450 lb. of lime, three tons of cattle manure and 30 lb. P_2O_5 in the from of super phosphate, was started in the first crop season of 1954–53 and continued upto the second crop season

of 1954–55, crops being raised during both the seasons in a year. Lime was applied 10 to 12 days before planting and super phosphate on the day of final ploughing. Both ammonium sulphate and chilean nitrate were applied as top dressing one month after planting. Strain MGL. 2 was used for the first crop and strain PTB. 20 for the second crop. The residual effect of the different treatments was also studied during the first crop season of 1955–56. Soil from the field was analysed before and after the experiment both for fertility status and pH value.

The data are presented in tables I to V

Discussion: It will be seen from the results that in the first crop season (Table I) chilean nitrate at both 40 lb. and 60 lb. nitrogen over basal dressing is better than ammonium sulphate at both the levels over basal dressing, the increase in percentage though not signifiicant being 4·8 and 3·9 respectively. In the second crop season (Table II) ammonium sulphate at 60 lb. nitrogen over basal dressing has recorded 16·6% significantly higher yield than chilean nitrate over basal dressing at the same level. It is also interesting to note that during the first season of the trial chilean nitrate both alone and over basal dressing has recorded better yields than ammonium sulphate alone and over basal dressing. It is also seen that 40 lb. N per acre in the form of chilean nitrate appears to be the maximum dose, the higher dose of 60 lb. producing some depressing effect during both the seasons. The results of the combined analysis of all the six seasons (Table III) show that both ammonium sulphate and chilean nitrate over basal dressing are on a par and that both these fertilisers when applied alone have recorded significantly low yields. The above findings are also in conformity with the results of the residual effect (Table IV) where the treatments that received a basal dressing (Nos. 1, 2, 3, 6 & 7) have recorded significantly higher yields (except treatment 7) over those treatments that did not receive any basal dressing (Nos. 4, 5, 8 & 9). In other words, the continuous application of these fertilisers in such heavy doses as 40 lb. and 60 lb. N per acre alone, without any basal dressing for a period of 3 years when 6 crops were raised has had some deleterious effect on the soil resulting in significantly low yields.

This experiment has also revealed that in West Coast soils, which are acidic in nature the nitrogen may be applied in the from of chilean nitrate since continuous application of ammonium sulphate would increase acidity. This fact is amply borne out by this

experiment where the original pH of the soil 5·53, (Table V) was reduced to 5·1 (treatments 4 & 5) by continuous application of ammonium sulphate alone while the original value has almost been maintained by a similar application of chilean nitrate in treatments 8 and 9. It must however be stated that the heavy application of both these fertilisers did not produce any adverse effect when applied over a basal dressing, as is seen from the pH values, the yield data and the residual effect.

Summary: 1. Chilean nitrate is found to compara favourably with ammonium sulphate as manure for rice, chilean nitrate proving slightly better during the first crop season and ammonium sulphate during the second crop season.

2. The continuous application of ammonium sulphate alone has been found to slightly increase the acidity of the soil, as indicated by the pH values.

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TABLE I

Chilean Nitrate Experiment

Treatments:

1 Basal dressing of lime 450 lb. plus cattle manure 3 tons plus Super phosphate to supply 30 lb. P_2O_5 per acre (control)
2 As in treatment 1 plus ammonium sulphate to supply 40 lb. N/acre
3 As in treatment 1 plus ammonium sulphate to supply 60 lb. N/acre
4 Ammonium sulphate alone 40 lb. N/acre
5 Ammonium sulphate alone 60 lb. N/acre
6 As in treatment 1 plus chilean nitrate 40 lb. N/acre
7 As in treatment 1 plus chilean nitrate 60 lb. N/acre
8 Chilean nitrate alone 40 lb. N/acre
9 Chilean nitrate alone 60 lb. N/acre

Layout: 9 x 5 randomised blocks

Plot size: 40' x 6'

First Crop Season's 1

	1952—53		1953—54		1954—55		Combined analysis of three seasons	
	Acre yield in lb.	% on Control	Acre yield in lb.	% on Control	Acre yield in lb.	% on Control	Acre yield in lb.	% on Control
1	2204	100·0	3494	100·0	1992	100·0	2563	100·0
2	2241	101·8	3172	90·8	2096	105·2	2503	97·7
3	2136	97·0	3222	92·2	2105	105·6	2488	97·1
4	2014	91·5	2616	76·7	1865	93·6	2165	84·5
5	2009	91·3	2704	79·2	1901	95·4	2205	86·0
6	2350	106·7	3376	98·9	2155	108·2	2627	102·5
7	2395	108·8	3332	97·6	2043	102·5	2590	101·0
8	2309	104·9	2774	81·3	1674	84·1	2252	87·9
9	2309	104·9	2998	87·8	1679	84·3	2329	91·1
General Mean	2218·5	100·8	3076 4	89 4	1945·6	97·7	2413·6	94·2
Standard error	104·8	47·6	118·4	3·44	99·8	5·01	128·1	5·0
'F' test	Satisfied		Satisfied		Satisfied		Satisfied	
C. D. P=0 05	213·6	9·7	240·8	7·0	203·2	10·2	271·6	10·6

Conclusion:

1952—53: 7 6 9 8 2 1 3 4 5

1953—54: 1 6 7 3 2 9 8 5 4

1954—55: 6 3 2 7 1 5 4 9 8

Combined analysis: 6 7 1 2 3 9 8 5 4

TABLE II

Second Crop Seasons' Results

Treatments as in Table I

	1952—53		1953—54		1954—55		Combined analysis of three seasons	
	Acre yield in lb.	% on Control	Acre yield in lb.	% on Control	Acre yield in lb.	% on Control	Acre yield in lb.	% on Control
1	1666	100 0	2027	100 0	1622	100·0	1772	100·0
2	1856	111·4	1946	96·0	2050	123·4	1951	110·2
3	1736	104·2	2214	109·2	2146	129·1	2032	114·7
4	1410	84·6	1430	70·5	1617	97·4	1486	83·9
5	1154	69·2	1299	64·1	1777	106·9	1410	79·6
6	1727	103·6	1962	96·8	1861	111·9	1850	104·5
7	1607	96·4	1720	84·8	1888	114·0	1738	98·1
8	1378	82·7	1507	74·3	1467	88·2	1451	81·9
9	1453	87·5	1657	83·5	1586	95·4	1565	88·4
General Mean	1554	93·3	1751·3	86·6	1779·3	107·4	1695	95·7
Standard error	138·2	8·3	177·7	8·79	110 6	6·68	113·0	6·38
'F' test	Satisfied		Satisfied		Satisfied		Satisfied	
C. D. P=0·05	288·2	16·9	361·9	17·9	225·2	13·6	239·1	13·5

Conclusion :

1952—53: 2 3 6 1 7 9 4 8 5

1953—54: 3 1 6 2 7 9 8 4 5

1955—55: 3 2 7 6 5 1 4 9 8

Combined analysis: 3 2 6 1 7 9 4 8 5

TABLE III

Combined Analysis of Six Seasons' Results

Treatments as in Table I

	Acre yield in lb.	Percentage on control
1	2168	100·0
2	2227	102·8
3	2265	104·5
4	1825	84·5
5	1807	83·3
6	2239	103·2
7	2159	99·6
8	1852	85·4
9	1947	89·8
General mean	2054·3	94·8
Standard error	107·9	4·98
'Z' test satisfied or not	Satisfied	
Critical difference P=0·05	218·9	10·1

Conclusion :

3 6 2 1 7 9 8 4 5

TABLE IV

1956—56 First Crop Seasons' Results (Residual effect)

Treatment as in Table I

	Acre yield in lb.	Percentage on control
1	1787	100·0
2	1674	93·6
3	1714	95·9
4	1488	83·2
5	1459	81·6
6	1708	95·5
7	1861	101·6
8	1499	83·9
9	1537	86·0
General mean	1636·3	91·3
Staadard error	77·1	4·3
'Z' test satisfied or not	Satisfied	
Critical difference P=0·05	157·7	8·8

Conclusion :

7 1 3 6 2 9 8 4 5

TABLE V

pH. Value

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
pH before trial: 5·53									
pH after trial:	5·62	5·48	5·40	5·11	5·01	5·60	5·80	5·40	5·54