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Influence of Neem Cake Mixed Ammonium Sulphate on the Yield and Nutrient Uptake By IR 20 Rice (*Oryza sativa* L.)*

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The results of a field experiment to study the effect of neem cake mixed $(NH_4)_2SO_4$ application at different levels to rice Var. IR 20 revealed that the yield of rice grain and straw were significantly influenced by the various treatments. Among the treatments tried, 30 per cent neem cake mixed $(NH_4)_2SO_4$ at 120 kg N/ha recorded the highest grain and straw yield and the uptake of N and P. Irrespective of the levels of N, mixing of neem cake gave higher profit/ha compared to untreated $(NH_4)_2SO_4$. Neem cake effectively regulated the nitrification rate thereby increased the conservation of NH_4-N in soil for longer period. The present investigation indicated that the nitrification inhibition property of neem cake extended well beyond 30 days after application of the same.

The loss of nitrogen from the soil system can be high, with the leaching of NO_3 being the main source of loss (Allison, 1966). Laboratory studies have shown that under alternate draining and submergence, a condition operating in uplands, the loss of mineral N could be as high as 95 per cent within a period of 8 weeks after transplanting (Rajale, 1970). However, in growth chamber experiments Stefanson and Greenland (1970) measured losses of the order of 22kg N/ha as nitrous oxide in three weeks if the moisture was maintained close to field capacity with adequate NO_3 supply. The use of chemicals to limit the nitrification of NH_4 to the more easily leachable and denitrifiable NO_3 has been reported by numerous workers. Gasser (1970) reviewed the work on the chemical inhibitors. Although a number of non-commercial chemicals have been used (Andreeva and Sheheglova, 1968), two promising compounds are available commercially. The first of these, a pyridine derivative, 2-chloro-6 (trichloro-methyl) - pyridine, registered under the name of 'N-Serve(R)', and the other, a substituted pyrimidine marketed as 'AM(R) have shown promises (Goring 1962a, 1962b; Gasser 1965; Patrick *et al*. 1968; Prasad and Lakhidive 1969). The latter compound has not been shown to be as effective as 'N-Serve', (Gasser, 1970). These chemicals are, however, very costly and require to be imported. This necessitated, the need for a suitable substitute of local availability and cheap source. Recently it has been reported that alcohol extract of neem seed crush could be used as nitrification inhibitor (Sinha 1954, Singh 1966). Ketkar (1976)

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has written an excellent monograph about the various uses of neem products. Hence to fill in the lacuna about utilization of neem cake as nitrification regulator this investigation was undertaken.

This paper reports a field experiment designed to examine the effect of neem cake on soil mineral nitrogen at different periods of sampling and on the yield of IR 20 rice. Its influence on the nutrient uptake by grain and straw are also examined.

MATERIAL AND METHODS

A field experiment was laid out in the wetlands of Tamil Nadu Agricultural University farm at Coimbatore to study the effect of neem cake blended $(NH_4)_2SO_4$ application on yield and nutrient uptake. The initial soil sample collected from the experimental field was analysed by adopting standard methods and the results of analysis are presented below.

pH (1:2)	7.7
E.C.(m.mhos/cm)	0.31
Organic carbon (per cent) ..	0.46
Available N (kg/ha)	... 276.38
Available P (kg/ha)	... 16.12
Available K (kg/ha)	... 378.32
C.E.C. (me/100 g)	... 26.84
Textural class	... Sandy clay loam

The test crop was IR 20 rice. The treatments consisted of three levels (60, 90 and 120 kg N/ha) of N and two doses of neem cake (15 per cent and 30 per cent by weight of $(NH_4)_2SO_4$ used). The design adopted was RBD with three replications.

Mixing of neem cake with $(NH_4)_2SO_4$ Neemcake is an easily available indigenous oil seed cake. Due to the presence of certain toxic substances, this cake can not be fed to the cattle and its price is generally low (Rs.0.98/kg). The sample used contained 4.81 per cent N, 0.46 P and 1.92 per cent K on moisture free basis. The amount of N contributed by the neem cake was deducted from the corresponding N levels and the rest was applied as $(NH_4)_2SO_4$. Ammonium sulphate was treated with neem cake by moistening the lots kept in the polythene bags with acetone (25 ml/kg $(NH_4)_2SO_4$) and then adding the required quantity (15 per cent or 30 per cent by weight of $(NH_4)_2SO_4$) of finely powdered neem cake (passing through a 20 mesh sieve) and mixing the contents of the bags throughly (Reddy and Prasad, 1975). The N through $(NH_4)_2SO_4$ was applied as a single dose at the time of Planting. Superphosphate and muriate of potash were applied basally to supply 60 kg in each of P_2O_5 and K_2O/ha. The plants were grown to maturity and at harvest the yield of grain and straw were recorded separately. The plant samples collected at post harvest stage were analysed for N, P and K contents as per the procedure outlined by Jackson (1967). The soil samples drawn at three stages viz., 10, 20 and 30 days after the application of neem cake blended $(NH_4)_2SO_4$ as basal dose were analysed for ammoniacal and NO_3-N following the method of Keeney and Bremner (1966).

RESULTS AND DISCUSSION

The yield of rice grain and straw are presented in Table I and nutrients uptake in Table II.

TABLE I Effect of neem cake on the yield of IR 20 Rice
(Mean values kg/ha)

Treatment		Grain yield	Straw yield	% increase in yield due to neem cake blending: Grain	Straw
60 kg N/ha as $(NH_4)_2SO_4$		3139.8	5651.5	—	—
90 kg N/ha as $(NH_4)_2SO_4$		3719.6	6432 9	—	—
120 kg N/ha as $(NH_4)_2SO_4$		3910.5	7102.5	—	—
60 kg N/ha as $(NH_4)_2SO_4$ plus neem	15 per cent	3558.6	5993.4	13.34	6.05
cake	30 per cent	3713.4	6216.1	18.27	9.99
90 kg N/ha as $(NH_4)_2SO_4$ plus neem	15 per cent	3913.4	6800.4	5.21	5.71
cake	30 per cent	4120.7	7056.1	10.78	9.69
120 kg N/ha as $(NH_4)_2SO_4$ plus neem	15 per cent	4327.0	7644.4	10.65	7.63
cake	30 per cent	4582.9	7859.5	17.19	10.66

	Grain: S.E. of mean	Grain: C.D. (P=0.05)	Straw: S.E. of mean	Straw: C.D. (P=0.05)
Treatments	9.34	27.15	8.39	24.40
Doses of neem cake	4.99	14.51	4.49	13.04
Treatment x doses of neem cake	13.20	38.39	11.17	34.51

It was observed (Table I) that the yield of rice grain and straw increased significantly with increase in N levels tried. It is interesting to note that the application of neem cake mixed $(NH_4)_2SO_4$ significantly increased the yield of rice grain and straw at all levels of N application compared to untreated $(NH_4)_2SO_4$. It was again noteworthy that neem cake mixed $(NH_4)_2SO_4$ at 90 kg N/ha and untreated $(NH_4)_2SO_4$ at 120 kg N/ha did not differ significantly with regard to their effect on yield. The increase in yield due to 30 per cent neem cake mixed $(NH_4)_2SO_4$ application at 120 kg N/ha was 672.4kg/ha (17.19 per cent) over untreated $(NH_4)_2SO_4$ of the same level. At 60kg N/ha applied as $(NH_4)_2SO_4$ the increase in grain yield was of the order of 418.8 kg/ha (13.34 per cent) by blending it with 15 per cent of neem cake. The increase in yield of rice grain was 573.6 kg/ha (18.27 per cent) for the same level of (60 kg N/ha) $(NH_4)_2SO_4$ with 30 per cent neem cake. This indicated that by merely increasing the neem cake dose by about 15 per cent, the increase in rice grain yield was 154 kg/ha. Irrespective of the levels of N applied, neem cake mixed $(NH_4)_2SO_4$ significantly increased the rice grain and straw yield. These results are in close agreement with that of Bains *et al*. (1971), Ketkar (1974) and Harishanker *et al*. (1976). Increase in dosage of inhibitor increased the yield of rice grain and straw due to the mixing of $(NH_4)_2SO_4$ with neem cake noted in the present investigation might be due to the retardation of nitrification of applied $(NH_4)_2SO_4$ by neem cake. Such inhibition might have facilitated the slow and steady release of N to the plants at required time which favoured an increase in growth and yield of rice grain and straw (Bains *et al*. 1974; Ketkhar, 1976). Further the increase in the yield of rice grain and straw almost parallelled with that of increase in the NH_4-N content of the soil resulting due to mixing of $(NH_4)_2SO_4$ with neem cake.

Nutrient uptake by IR 20 Rice: The uptake of N, P and K by grain and straw of rice presented in Table II revealed that there was significant increase in the uptake of N and P with increase in the level of N applied either with or without neem cake mixing. Similar observation were also made by Thirunavukkarasu *et al*. (1978). Irrespective of levels of N tried, there was highest uptake of N and P due to neem cake blending of $(NH_4)_2SO_4$. The highest uptake of N and P was seen at 120 kg N/ha level as $(NH_4)_2SO_4$ mixed with 30 per cent neem cake in both grain and straw. This is in agreement with the report made by Harishanker *et al*. (1976) who noticed that there was increased uptake of N and P by rice crop due to neem cake blended $(NH_4)_2SO_4$ application between the doses of neem cake tried, there was significant increase in the uptake of N and P at 30 per cent, neem cake mixed $(NH_4)_2SO_4$ application irrespective of levels of N tried. It was observed that with the increase in the dose of neem cake from 15 per cent to 30 per cent, there was a corresponding

TABLE II. Influence of neem cake on the uptake of nutrients by IR 20 Rice (kg/ha)

		Grain			Straw		
		N	P	K	N	P	K
60 kg N/ha as $(NH_4)_2SO_4$		61.79	8.08	15 19	39.76	3.62	42.81
90 kg N/ha as $(NH_4)_2SO_4$		69.57	10.34	13.07	43.93	5.22	38.68
120 kg N/ha as $(NH_4)_2SO_4$		77.77	12.16	10.18	48.48	6.45	30.07
60 kg N/ha as $(NH_4)_2SO_4$ plus neem cake	15 per cent	65.23	9.11	12.59	43.31	4.36	47.54
	30 per cent	67.95	10.29	13 89	47.48	5.67	52.65
90 kg N/ha as $(NH_4)_2SO_4$ plus neem cake	15 per cent	73.32	10.71	9.97	49.32	6.06	41.70
	30 per cent	78.43	11.00	11.51	51.32	6.92	46.56
120 kg N/ha as $(NH_4)_2SO_4$ plus neem cake	15 per cent	82.56	13.11	8.24	53.23	7.53	35.70
	30 per cent	84.85	13.98	9.42	55.03	8.60	41.73

	Grain		Straw	
	S.E. of mean	C.D.(P=0.05)	S.E. of mean	C.D.(P=005)
i. N uptake	0.27	0.79	0.37	1.07
ii. P uptake	0.04	0.12	0.08	0.24
iii. K uptake	0.15	0.43	0.41	1.18

decrease in nitrification (Table IV) rate. This might have provided the available N at a steady rate to meet the N requirement of rice plants. This is in agreement with the findings of Patil (1972). The uptake of K showed a decreasing trend with every increase in the level of N application in the case of grain and straw with or without neem cake mixing. At 60 kg N/ha level there was highest uptake of K and decreased with further increase in the level of N. This trend was true with or without neem cake mixing. With increasing levels of NH_4, the availability of K is decreased because of blocking effect which could have resulted in the reduced uptake of K. This is in agreement with the observations of Welch and Scott (1961).

Economics of blending $(NH_4)_2SO_4$ with neem cake : The increase in the yield of rice and the profits accrued thereof due to neem cake mixed $(NH_4)_2SO_4$ application to rice crop are summarized in Table III. It could be seen that irrespective of levels of N application there was increased yield of rice grain and straw due to neem cake mixing. At 120 kg N/ha level, the increased yield of rice grain and straw due to mixing of $(NH_4)_2SO_4$ with 30 per cent neem cake were 67 .4 and 757.1 kg/ha respectively over untreated $(NH_4)_2SO_4$. Taking the price of paddy as Rs. 100/quintal and straw at Rs. 20/tonne, the net additional income due to 30 per cent neem cake blended $(NH_4)_2SO_4$ application at 120 kg N/ha level comes to Rs. 637.20/ha. By a similar comparison it was also noted that the 30 per cent neem cake blended $(NH_4)_2SO_4$ to supply 90 kg N ha yielded a net profit of Rs. 398.90 over untreated $(NH_4)_2SO_4$. A net profit of Rs. 410/ha was observed under 60 kg N/ha level of 15 per cent neem cake mixed $(NH_4)_2SO_4$ application and Rs. 556/ha for 30 per cent neem cake dosage. It was observed that higher net profit in terms of Rs/ha was obtained with 30 per cent dose of neem cake rather than 15 per cent neem cake irrespective of the levels of N tried. This is in agreement with the findings of Ketkar (1974) who reported increased net profit/ha due to neem cake blended $(NH_4)_2SO_4$ application to rice crop.

Effect of neem cake mixed $(NH_4)_2SO_4$ on soil mineral nitrogen : The summary of results of NH_4-N and NO_3-N contents of soil samples collected at three different periods are given in Table IV.

With increase in the level of N, there was corresponding increase in the contents of NH_3 N and NO_3 N in all days of sampling with or without neem cake. This is in close agreement with the observations of Muthuswamy *et al.* (1977). It was noticed that there was significantly higher NH_4 N content in the neem cake mixed $(NH_4)_2SO_4$ applied plots compared to untreated $(NH_4)_2SO_4$ applied plots at all levels of N tried. The highest NH_4 N was registered by 30 per cent neem cake mixed $(NH_4)_2SO_4$ treatments to supply 120 kg N/ha. This could be ascribed to the reduced mineralization of NH_4-N to NO_3-N in the presence of neem cake while in the untreated ones there was increased mineralization of NH_4-N to NO_3-N as seen by the higher amount of NO_3-N (Table IV). This effect is more pronounced at higher levels of neem cake (30 per cent). The reduction in the nitrification rate might be due to

TABLE III Economics of blending $(NH_4)_2SO_4$ with neem cake

Treatment		Mean yield (kg/ha)		Increase in yield due to neem cake blending		Increase inincome obtained due to neem cake mixing		Cost of neem cake Rs. P.	Net profit
60.0 kg N/ha as $(NH_4)_2SO_4$		3139.6	5651.5	—	—	—	—	—	—
90.0 kg N/ha as $(NH_4)_2SO_4$		3719.6	6432.9	—	—	—	—	—	—
120 0 kg N/ha as $(NH_4)_2SO_4$		3910.5	7102.4	—	—	—	—	—	—
60.0 kg N/ha as $(NH_4)_2SO_4$ plus	15 per cent	3558.6	5993.4	418.8	341.9	418.80	6,84	8.80	410.00
neem cake	30 per cent	3713.4	6216.1	573.6	564.6	573.60	11.30	17.60	556.00
90.0 kg N/ha as $(NH_4)_2SO_4$ plus	15 per cent	3913.4	6800.4	193.8	367.5	193.80	7.36	13.25	180.55
neem cake	30 per cent	4120.7	7056.1	401.1	623.2	401.10	12.46	26.50	374.60
120.0 kg N/ha as $(NH_4)_2SO_4$ plus	15 per cent	4327.0	7644.4	416.5	542.0	416.50	10.84	17.60	398.90
neem cake	30 per cent	4582.9	7859.5	672.4	757.1	672.40	15.14	35.20	637.20

TABLE IV Influence of neem cake on the NH_4-N and NO_3-N contents in the soil (ppm on moisture free basis)

Treatment		NH_4-N			NO_3-N		
		10 days	20 days	30 days	10 days	20 days	30 day
60 kg N/ha as $(NH_4)_2SO_4$		55.44	28.73	12.76	21.38	28.93	41.74
90 kg N/ha as $(NH_4)_2SO_4$		71.79	41.29	12.89	30.53	46.14	51.55
120 kg N/ha as $(NH_4)_2SO_4$		85.16	58.58	13.16	40.66	55.78	69.02
60 kg N/ha as $(NH_4)_2SO_4$ plus	15 per cent	56.67	31.97	14.95	16.63	27.34	38.18
neem cake	30 per cent	65 73	38.41	17.47	13 34	22.51	31.13
90 kg N/ha as $(NH_4)_2SO_4$ plus	15 per cent	70.33	41.73	17.07	24.73	33.73	46.46
neem cake	30 per cent	81.27	48 26	20 52	20.87	28.99	39.79
120 kg N/ha as $(NH_4)_2SO_4$ plus	15 per cent	84.43	56 59	18 59	30.43	42.52	51.22
neem cake	30 per cent	98.03	63.26	26.07	26.45	37.00	45.76

	NH_4-N		NO_3-N	
	S.E. of mean	C.D. (=0.05)	S.E. of mean	C.D. (P=0.05)
Stages	0.15	0.42	0.11	0.33
Doses of neem cake	0.12	0.34	0.09	0.27
Treatment... ...	0.23	0.64	0.17	0.50
Stages x treatment	0.40	1.11	0.31	0.86
Doses x treatment	0.32	0.91	0.25	0.70

inhibition in the activities of organisms converting NH_4 to NO_2 and subsequently to NO_3 by the total bitter fraction as well as lipid associates of neem cake (Sahrawat and Parmar 1975; Misra *et al.* 1975). The results indicated that mixing of neem cake with $(NH_4)_2SO_4$ effectively conserves NH_4-N. The efficacy of mixing $(NH_4)_2SO_4$ with neem cake has been reported by Ketkar (1971), Reddy and Prasad (1975) and Harishanker *et al.* (1976). Among the different periods of sampling it was observed that on the 10th day there was significantly higher (63.99 ppm) content of NH_4-N in the soil and gradually decreased to 14.28 ppm on 30th day. This showed that at the initial stage (10th day) inhibitory effect of neem cake on nitrification was well pronounced. The gradual decline in the NH_4-N content might be attributed to the gradual oxidation of NH_4-N to NO_3 N under favourable environmental condition. There was little difference in the NH_4-N content in the soil sample collected at 30th day among different levels of $(NH_4)_2SO_4$ with or without neem cake treatment. This clearly indicated the role of neem cake as nitrification inhibitor even under field condition. The amount of NO_3-N in the soil under varions treatments increased with time, showing that the neem cake was effectively inhibiting the nitrification process only upto a particular period which is governed by the concentration or the dose of the material. Between the doses of neem cake employed, 30 per cent neem cake mixed with $(NH_4)_2SO_4$ was found to be effectively inhibiting the conversion of NH_4-N to NO_3-N compared to 15 per cent dose. This was true at all levels of N tried. This could further be elucidated from the fact that 30 per cent neen cake dose recorded significantly lower (31.95 ppm) NO_3-N compared to 15 per cent dose (38.88 ppm). This is in agreement with the results reported by Sahrawat and Parmar (1975). The interaction between doses of neem cake and treatments was also found to be significant showing that, irrespective of treatments, 30 per cent neem cake dose recorded significantly lower NO_3-N content in the soil compared to 15 per cent. Further it was also observed that the NO_3-N content in the soil sample collected at 30th day varied markedly between treated and untreated $(NH_4)_2SO_4$ with neem cake. Thirty per cent neem cake blended $(NH_4)_2SO_4$ treatment registered significantly lower NO_3-N content in the soil sample collected at 30th day. This amply revealed that neem cake possesses nitrification regulatory property well upto 30 days from the date of application.

It is concluded from the study that by treating $(NH_4)_2SO_4$ with neem cake it could be possible to conserve N in the soil to a certain extent which otherwise might be lost due to denitrification and consequently by leaching and volatilization. The use of neem cake to reduce the rate of nitrification of added $(NH_4)_2SO_4$ was effective even under field conditions. This increases the efficiency of N, the most costly fertilizer nutrient. Hence there is great scope for economising N use for profitable agriculture by blending N fertilizer with neem cake which would reduce a considerable amount of foreign exchange.

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