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COMPARATIVE MINERALISATION EFFECT OF SLOW RELEASE FERTILIZERS IN SOILS OF CHOLAVANDAN BASIN TRACT - TAMIL NADU

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ABSTRACT

The comparative mineralisation effect of Urea formaldehyde (UF), Tarcoated urea (TCU) and Lac coated urea (LCU) was studied in the predominant soil series of Cholavandan basin tract of Tamil Nadu under two moisture regimes. The results showed that after 4 days of incubation, the amount of urea was the lowest in the treatment receiving urea in all the soils and the two moisture regimes. The amount of urea released from LCU and TCU immediately after application in soils was quite high. The rate of release of urea-N from UF was the highest in all the soil series. The amount of NH_4N found in soils treated with different fertilizers was in the order Urea TCU LCU UF. The conversion of NH_4 to NO_2 and NO_3 form with urea was rapid in the case of Padugai and Anaiyur series particularly in 75% WHC moisture regime. The rate of decomposition of all the fertilizers is more in Palaviduthi series, whereas in padugai and Anaiyur series it is slow and incomplete.

Key Words : Mineralisation, Slow Release Fertilizers.

Considerable loss of N through NH_3 volatilization takes place when urea is applied to soil. In order to minimise the volatilisation loss, various coated urea fertilizers have been introduced. The efficiency of these modified form of urea fertilizers mostly depends upon their mineralisation and hydrolysis in soil. The release of nitrogen from these fertilizers is mainly controlled by soil characteristics as well as moisture condition. Hence, the present study was carried out to compare the mineralisation of coated fertilizers under two levels of moisture in three different soil series of cholavandan rice tract of Periyar Vaigai irrigation project command area in Madurai District.

MATERIALS AND METHODS

Surface soil samples (0-20 cm) of Palaviduthi series (Typic Haplustalfs), Anaiyur series (Vertic Haplustalfs) and Padugai series (Typic Ustifluvents) the predominant soil series in this tract were collected from the rice fields of Cholavandan area of Madurai District of Tamil Nadu (Peer Mohamed, 1988). The soils were sandy clay loam with pH ranging from 5.0 to 8.2 and free from salinity hazards.

Portions of 40 g soil samples were taken in a number of plastic beakers and treated with 300 ppm of N in the form of (i) Urea 46% N, (ii) Lac coated urea (LCU) 36.2% N, (iii) Tar coated urea (TCU) 35% N and (iv) Urea formaldehyde (UF) 40% N where urea: formaldehyde ratio was 4:1. The soils were incubated in the laboratory at room temperature (20-33°C) under two moisture regimes namely (i) moist at 75% water holding capacity (WHC) and (ii) waterlogged with the level of standing water at a height of 5 cm above the soil surface. Each treatment was replicated four times. the moisture level was maintained constant by the addition of requisite quantity of distilled water. The beakers were covered with a thin polythene sheet using a rubber band around the rim. The soil sample along with standing water in the case of waterlogged treatments were analysed periodically for (i) urea nitrogen (2) Ammoniacal nitrogen and (3) Nitrate + nitrite nitrogen. The soil samples were extracted with 2N KCl containing 5 ppm phenyl mercuric acetate (Urease inhibitor) solution

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soil/solution ratio (1:10). From this extract, urea-N was estimated colorimetrically using diacetyl monoxime and thiosemicarbazide following the procedure described by Douglas and Bremner (1970). The extract was also analysed for NH_4^+N by steam distillation with ignited MgO and subsequently for NO_3 + NO_2^-N by distilling the residue in the flask with Devardas' alloy, absorbing the evolved NH_3 in 4% boric acid and titrating the same with standard H_2SO_4 solution (Black, 1965).

RESULTS AND DISCUSSION

The results showed that after 4 days of incubation, the amount of urea was the lowest (Table 1) in the treatment receiving urea in all the soils and the two moisture regimes. Further, it is very clear that urea-N could not be estimated in any of the three soil series after 7 days of incubation under waterlogged condition and after 4 days when the moisture regimes was 75% WHC. The disappearance of urea-N under the 75% WHC moisture regime was much quicker as compared to that of waterlogged condition. This might be due to its more rapid hydrolysis to $(NH_4)_2CO_3$ under 75% WHC moisture regime which is favourable for higher urease enzyme activity (Sahu and Pal, 1987). The release of urea N from the TCU and LCU in all the soil series were similar irrespective of the moisture regimes. The amount of urea released from TCU and LCU

Table 1. Urea-N content of soils (Percentage of added N)

Treatment		Days of Incubation 0	4	7	14	21	28	42	56	70
					Waterlogged condition					
Padugai	UF	81.2	34.2	19.6	12.3	6.8	-	-	-	-
	TCU	62.5	18.4	7.8	-	-	-	-	-	-
	LCU	60.9	17.0	7.0	-	-	-	-	-	-
	Urea	90.3	8.9	-	-	-	-	-	-	-
Anaiyur	Uf	76.7	27.3	16.2	10.1	4.6	-	-	-	-
	TUC	58.8	15.6	5.2	-	-	-	-	-	-
	LCU	57.6	14.2	4.8	-	-	-	-	-	-
	Urea	88.4	7.2	-	-	-	-	-	-	-
Palaviduthi	UF	84.0	54.3	30.3	24.3	11.8	4.9	3.1	1.9	1.2
	TUC	63.4	5.6	0.9	-	-	-	-	-	-
	LCU	62.5	4.8	1.0	-	-	-	-	-	-
	Urea	92.9	2.1	0.2	-	-	-	-	-	-
					75% waterholding capacity condition					
Padugai	UF	81.2	16.8	13.5	4.3	3.2	1.6	1.0	-	-
	TCU	62.5	4.0	3.1	-	-	-	-	-	-
	LCU	60.9	3.9	2.6	-	-	-	-	-	-
	Urea	90.3	1.0	-	-	-	-	-	-	-
Anaiyur	UF	76.7	15.2	12.3	4.0	2.9	1.2	0.7	-	-
	TCU	58.8	3.2	1.9	-	-	-	-	-	-
	LCU	57.6	3.0	1.6	-	-	-	-	-	-
	Urea	88.4	1.2	-	-	-	-	-	-	-
Palaviduthi	UF	84.0	16.6	14.2	10.1	5.8	0.6	0.2	-	-
	TCU	63.4	2.2	1.0	-	-	-	-	-	-
	LCU	62.5	2.1	0.8	-	-	-	-	-	-
	Urea	93.1	0.3	-	-	-	-	-	-	-

immediately after application in soil was quite high which might be due to the breakdown of coating of LCU and TCU granules during shaking with 2N KCl for one hour. Comparing thee types of coated fertilizers, the amount of urea-N released from the UF was higher proportion of free crystalline urea (Prasad *et al.*, 1971). However, the rate of release of urea-N from UF was higher in all the soil series. On any particular day after incubation, the amount of urea N release from soil was higher in waterlogged condition than 75% WHC moisture condition which was mainly due to more rapid enzymatic hydrolysis of urea. Comparing the urea N present among three soil series Palaviduthi series recorded high followed by Padugai and Analyur.

Ammoniacal-N

The conversion of urea to NH_4-N was the highest and more quick in urea indicating 62.0 to 86.2 per cent of the added nitrogen was found in NH_4 form within 4 days of incubation in the soils under waterlogged conditions. Among the different fertilizers, urea was closely followed by TCU and LCU. Reddy and Prasad (1975) also observed that the behaviour of LCU under waterlogged condition was more or less like urea after two weeks of incubation. In the case of UF, only 34.8 to 42.7 per cent of added nitrogen was converted to NH_4-N under similar period and moisture condition. The amount of NH_4-N found in soils treated with different fertilizers was in the order of: Urea TCU LCU UF. The amount of

Table 2. Net production of NH_4-N in soils (Percentage of added N)

Treatment		Days of incubation 0	4	7	14	21	28	42	56	70
Waterlogged condition										
Padugai	UF	5.3	35.6	30.4	26.2	17.1	5.2	2.6	1.8	1.9
	TCU	4.0	58.3	44.7	14.6	10.2	4.9	1.9	1.0	0.6
	LCU	3.8	53.6	42.8	15.0	11.4	5.8	2.6	1.9	1.0
	Urea	6.4	63.6	54.7	22.0	12.8	4.2	2.3	0.8	0.2
Analyur	UF	5.8	34.8	29.6	24.8	16.2	5.0	2.5	1.9	1.9
	TCU	3.9	59.2	44.9	13.9	10.0	5.2	1.6	1.1	0.8
	LCU	4.1	55.2	42.0	15.8	11.0	6.0	3.2	-	-
	Urea	6.9	62.0	53.2	24.6	12.0	4.8	2.6	0.9	0.4
Palaviduthi	UF	3.4	42.7	58.8	33.5	26.4	19.2	6.8	2.8	0.5
	TCU	3.1	75.6	68.2	36.2	27.4	19.0	5.2	2.9	2.0
	LCU	3.6	74.0	69.5	36.0	20.1	20.2	6.4	3.1	2.1
	Urea	4.8	86.2	74.3	48.9	31.4	19.9	3.6	0.9	-
75% waterholding capacity condition										
Padugai	UF	5.3	3.2	2.0	1.4	1.2	1.2	1.0	0.6	-
	TCU	4.0	6.3	2.9	2.0	1.5	1.2	0.7	0.3	0.2
	LCU	3.8	5.4	2.6	1.3	1.0	0.9	0.8	0.6	0.4
	Urea	6.9	9.3	2.2	1.5	0.8	0.5	0.3	-	-
Analyur	UF	5.8	3.4	2.3	1.6	1.0	0.8	0.2	-	-
	TCU	3.9	5.8	2.5	1.7	1.5	1.4	0.8	0.3	-
	LCU	4.1	6.0	2.8	2.4	1.8	1.0	0.6	0.2	-
	Urea	6.9	8.9	3.1	1.8	0.6	0.3	0.2	-	-
Palaviduthi	UF	3.4	72.6	61.2	39.2	24.8	9.9	3.6	2.2	0.0
	TCU	3.1	92.6	81.2	59.2	34.8	19.9	4.6	3.2	0.0
	LCU	3.6	94.3	82.5	62.4	33.3	17.9	3.6	2.8	1.0
	Urea	4.3	86.7	80.7	49.6	22.5	7.8	2.6	2.0	-

NH_4-N was higher in Palaviduthi than Anaiyur and Padugai series. Similar observations were reported by Sannigrahi and Mandal (1987). In Palaviduthi soil series, generally the amount of NH_4-N was found to be higher under 75% WHC moisture condition whereas the trend was just reverse in the case of other two series possibly due to the rapid nitrification of NH_4-N. As the incubation period increased the NH_4-N content of soil with all the fertilizer decreased gradually. This is possibly due to nitrification, NH_3 volatlliza-tion and NH_4 fixation in the lattice clay minerals. Further, rate of decrease was more rapid in the case of Padugai and Anaiyur series due to greater volatilization loss of NH_4-N.

Nitrate + Nitrite - N:

The conversion of NH_4-N to NO_2^- and NO_3^- form with urea was rapid in the case of Padugai and Anaiyur series particularly in 75% WHC moisture regime (Table 3). After 28 days of incubation, (under 75% WHC) 79.9% and 79.2% of the applied N was found in these forms in Anaiyur and Padugai series as compared to 52.3% in Palaviduthi series. The nitrification process was also high with UF, LCU and TCU

Table 3. Net production of (NO_3 + NO_2) N in soils (Percentage of added N)

Treatment		Days of incubation 0	4	7	14	21	28	42	56	70
Waterlogged condition										
Padugai	UF	2.4	1.5	2.6	5.5	7.9	20.9	16.3	15.1	14.3
	TCU	1.1	1.1	6.4	10.3	19.2	20.1	16.2	15.9	13.6
	LCU	1.0	1.0	7.2	11.4	19.0	22.4	15.6	15.0	13.8
	Urea	1.9	3.6	5.3	5.8	13.0	21.6	13.4	12.6	10.9
Anaiyur	UF	2.6	1.5	2.8	5.6	8.1	19.8	17.0	14.8	13.7
	TCU	1.2	1.2	6.8	10.1	19.0	19.3	15.9	15.2	14.6
	LCU	1.4	1.4	7.6	11.7	19.6	22.0	16.5	15.3	13.0
	Urea	2.1	4.1	6.0	6.4	14.2	20.8	14.9	14.3	12.8
Palaviduthi	UF	0.5	0.3	0.2	8.6	8.0	5.9	0.3	-	-
	TCU	1.1	0.2	0.8	2.9	4.6	2.1	0.1	-	-
	LCU	1.1	0.4	1.0	3.0	4.9	2.5	0.4	-	-
	Urea	1.3	1.0	0.7	8.6	3.2	2.0	-	0.4	-
75% waterholding capacity										
Padugai	UF	2.4	38.1	46.3	65.8	73.8	86.2	69.6	60.3	43.6
	TCU	1.1	40.6	52.7	70.4	76.8	90.3	71.2	63.1	43.4
	LCU	1.0	40.8	52.0	71.1	76.4	89.5	70.9	62.8	43.0
	Urea	1.7	64.2	66.1	66.8	71.9	79.2	64.3	44.6	29.8
Anaiyur	UF	2.6	39.8	47.3	67.6	75.0	84.2	68.7	60.8	42.8
	TCU	1.2	42.6	51.8	73.0	78.9	88.0	70.0	62.7	43.2
	LCU	1.4	41.6	52.6	71.8	76.8	89.0	71.3	60.3	42.8
	Urea	2.1	66.3	68.3	68.9	73.3	79.9	63.2	43.7	30.0
Palaviduthi	UF	0.5	1.5	7.3	24.2	39.0	39.6	30.2	31.8	24.6
	TCU	1.1	1.7	9.2	42.6	46.4	52.4	56.0	55.2	48.3
	LCU	1.1	1.6	9.0	37.8	45.0	53.4	56.2	55.4	47.2
	Urea	1.3	2.4	11.2	51.5	58.6	52.3	40.2	36.7	35.7

In these two soil series (75% WHC). Under waterlogged conditions, in all the three soil series, the nitrate plus nitrite-N recorded low content attributing more anaerobic environment which is not conducive for microbial oxidation of NH_4-N. Moreover waterlogged condition is highly favourable for microbial reduction of nitrate and nitrite-N to N_2O and N_2 gas. The nitrate and nitrite-N content showed a decreasing trend towards the end of the incubation period which is obviously due to denitrification losses.

REFERENCES

BLACK,C.A. 1965. Methods of soil. Analysis part 2. Am. soc. Agron. Inc., Madison, Wisconsin, USA.

DOUGLAS, L.A. and BREMNER, J.M. 1970. Extraction and colorimetric determination of urea in soils. *Proc. Soil Sci. Soc. Am.*, **34**: 859.

PEERMOHAMED, M. 1988. Pedology and resources of Cholavandan basin soils in Periyar-Vaigai command area, Tamil Nadu. Ph.D. Thesis submitted to Tamil Nadu Agricultural University, Coimbatore.

PRASAD,R., RAJALE, G.B. and LAKHDIVE, B.A. 1971. Nitrification retarders and slow release nitrogen fertilizers. *Adv. agron.*, **23**: 337.

REDDI, R.N.S. and PRASAD, R. 1975. Studies on the mineralization of urea, coated urea and nitrification inhibitor treated urea in soil. *J. Soil Sci.*, **26**: 304.

SAHU, S.K., PAL, S.S. 1987. Response of modified form of urea under low land rice cultivation. *J. Indian Soc. Soil sci.*, **35**: 146-148.

SANNIGRAHI, A.K. and MANDAL, L.N 1987. Mineralization of slow release nitrogenous fertilizers in soils. *J. Indian Soc. Soil Sci.*, **35**: 10-18.