zone' and the mesophyll. They range from spherical brachy sclereid like forms to highly branched trichosclereid like ones. They varied greatly in their size and cell wall thickness. Some have very thin secondary walls while other had thick walls. In some cases filled with ergastic inclusions like tannin (Table 1).

It is interesting to note that within the same seed coat, the various layers behave in different ways during ontogeny to result in varied types of sclereids. It is not well understood, the mechanism involved in leguminous seeds which differentiate the layers of sclereids.

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UREA HYDROLYSIS UNDER FLOODED CONDITION

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ABSTRACT

A laboratory experiment was conduced to study the hydrolysis of urea, using NK granule and ureagypsum in texturally varied rice soils. The results revealed that in clay loam soil, the hydrolysis of urea increased upto 3 days and decreased from 7th day onwards while, the peak of 4th and 5th day for urea gypsum, gaining a delay of 2 days. In sandy loam soil, the dydrolysis peak was on 7th and 9th day for urea and ureagypsum respectively.

KEY WORDS : Urea, Hydrolysis, Flooded Conditions

Urea hydrolysis is a biochemical reaction mediated by urease enzyme yielding ammonium carbonate which dissociates into NH_3 and CO_2. The hydrolysis is influenced by many factors like enzyme activity, concentration of the substrate and soil characteristics and the pattern of hydrolysis is measured in terms of unhydrolysed urea or amounts of inorganic nitrogen hydrolysed at specific period of time. It would be advantageous to control urea hydrolysis of flooded soils since this would decrease N loss due to NH_3 volatilisation and probably through other ways. The controlled release of urea based fertilizers or formulation with ureas inhibitors are the two approaches mostly suggested for slowing down the urea a hydrolysis. In the present investigation urea, NK granules and urea gypsum were used for hydrolysis study under flooded situation.

MATERIALS AND METHODS

win

(Entic chromustert) and Madukkur soil series (Typic haplustalf) were taken up for the study. The basic properties of the soils are presented in Table 1. Ten g of air dried soil was incubated for 15 days with 60 ppm of nitrogen using three sources *viz.*, prilled urea (46% N), ureagypsum (21% N) and NK granules (20% N). The incubation was carried out at room temperatures and the soils were maintained at submergences (2.5 cm) throughout the experimental period. The laboratory experiment

Table 1. Basic soil Characteristics

Soil properties	Adanur series	Madukkur series
Textural class	Clayloam	Sandy loam
Taxonomy	Entic chromustert	Udic haplustalf
Total N (Per cent)	0.102	0.085
Organic carbon (Per cent)	0.81	0.66
Available N (kg ha^{-1})	270	210
Exchangeable NH_4-N (ppm)	34.0	24.8
NO_3- (ppm)	1.08	1.20

Table 2. Ammoniacal-N content of soil (ppm) at progressive days after incubation

Soils and sources of N	Days after incubation (P)								
	1	2	3	4	5	7	9	13	15	Mean
Adanur series (S_1)										
Control (F_1)	35.2	44.8	50.4	53.2	62.1	48.1	70.5	73.7	51.7	54.5
Urea (F_2)	61.6	70.0	97.5	87.7	90.1	89.4	85.9	73.3	76.1	81.3
Urea gypsum (F_3)	58.8	75.9	79.3	89.6	89.6	86.3	77.0	77.0	89.1	79.6
NK granules (F_4)	62.1	79.0	73.3	82.6	82.6	121.3	82.1	81.0	83.1	83.8
Mean	54.4	67.4	75.3	78.3	78.3	86.3	78.9	76.2	73.5	74.8
Madukkur series (S_2)										
Control (F_1)	23.5	25.2	37.8	24.3	24.3	30.8	22.9	22.9	20.1	26.5
Urea (F_2)	40.1	45.7	39.7	48.1	48.1	55.1	42.9	21.0	23.8	40.8
Urea gypsum (F_3)	38.7	36.4	34.1	37.8	37.8	49.5	49.0	26.6	21.5	37.2
NK granules (F_4)	37.8	42.9	40.1	42.0	42.0	48.5	45.7	26.6	21.9	38.4
Mean	35.0	37.6	37.9	38.0	38.0	46.0	40.1	24.3	21.8	36.1
	S	F	P	SF	SP	PF	SPF			
SEd	0.7	0.9	1.5	1.3	1.9	2.9	4.0			
CD	1.3	1.8	2.9	2.6	4.0	5.7	8.0			

was in a completely randomised design with three replications. Separate sets of incubations were kept for stages of sampling *viz.*, 1, 2, 3, 5, 7, 9, 1 3 and 15 days of incubation. The inorganic N fractions *viz.*, NH_4^{-N} and NO_3^{-N} were estimated in 2 M KCI extract (Bremner, 1965). The total inorganic fractions of N at different periods, and nitrification rates were subjected to statistical processing

RESULTS AND DISCUSSION

The hydrolysis pattern of urea as measured by inorganic Nfractions differed widely between soils. Higher $NH4^{-4}N$ contents were observed in Adanur series than in Madukkur series (Table 2). Owing to the heavy texture (32% clay), high organic matter (0.815) content of the initial soil and higher NH_4^{-N} content which was reflected in the

Table 3. Nitrate-N content of soil (ppm) at progressive days after incubation

Soils and sources of N	Days after incubation (P)								
	1	2	3	4	5	7	9	13	15	Mean
Adanur series (S_1)										
Control (F_1)	8.9	11.7	19.4	17.7	20.5	20.5	21.0	24.5	32.0	19.3
Urea (F_2)	10.7	14.0	14.0	19.1	19.1	21.0	21.5	33.7	36.9	21.7
Urea gypsum (F_3)	9.3	10.7	17.7	22.4	17.3	18.7	21.9	27.6	27.6	19.1
NK granules (F_4)	8.9	11.2	13.5	19.6	22.9	24.7	20.5	37.3	28.5	20.8
Mean	9.5	11.9	15.1	19.7	19.9	21.2	21.2	31.2	31.2	20.2
Madukkur series (S_2)										
Control (F_1)	13.1	12.2	12.1	17.9	15.9	33.6	34.1	32.2	42.0	23.6
Urea (F_2)	14.5	17.3	21.0	21.5	35.9	33.6	35.9	44.6	44.3	29.8
Urea gypsum (F_3)	19.6	14.5	21.9	24.7	38.6	31.7	39.2	52.3	44.3	31.9
NK granules (F_4)	15.9	11.7	22.4	2.4	42.4	32.7	43.9	47.6	45.3	31.6
Mean	15.8	13.9	19.4	21.6	33.2	32.9	38.3	44.2	44.0	29.2
	S	F	P	SF	SP	PF	SPF			
SEd	0.3	0.4	0.6	0.5	0.8	1.1	1.6			
CD	0.5	0.7	1.1	1.0	1.5	2.2	3.1			

Table 4. Nitrification rate (%)

Soils and sources of N	1	2	3	4	5	7	9	13	15	Mean
	Days after incubation (P)									
Adanur series (S_1)										
Control (F_1)	20.1	20.7	20.0	25.0	24.9	29.9	23.1	22.6	38.4	25.0
Urea (F_2)	14.8	17.4	15.4	18.6	17.5	17.8	20.9	34.5	32.7	21.0
Urea gypsum (F_3)	13.7	11.3	14.6	20.0	16.1	17.4	22.2	25.8	24.6	18.4
NK granules (F_4)	12.5	11.5	16.9	19.2	20.2	17.8	20.0	32.5	25.6	19.5
Mean	15.3	15.2	16.7	20.7	19.7	20.7	21.3	28.8	30.3	21.0
Madukkur series (S_2)										
Control (F_1)	35.6	32.7	24.0	42.1	33.7	52.2	61.3	58.6	67.2	45.2
Urea (F_2)	26.4	31.1	34.8	30.9	41.7	37.8	45.6	67.9	65.0	42.4
Urea gypsum (F_3)	33.3	26.7	39.2	39.5	48.0	39.5	44.4	66.2	67.3	44.9
NK granules (F_4)	33.4	23.0	36.5	34.8	51.7	40.2	48.9	64.2	67.5	44.5
Mean	32.2	28.4	33.6	36.8	43.8	42.4	50.1	64.2	66.9	44.3
Mean	23.7	21.8	26.2	28.8	31.7	31.6	35.7	46.6	48.6	-
	S	F	P	SF	SP	PF	SPF			
SE_D	0.2	0.4	0.6	1.5	0.8	1.1	1.6			
CD	0.4	0.7	1.1	NS	1.5	2.2	3.1			

hydrolysed NH_4^{-N} from urea in Adanur series as compared to the open textured Madukkur sandy loam soil. On the contrary, Madukkur series had higher NO_3-N than Adanur series (Table 3). The reason again attributed to its light texture which would have favoured more nitrification leading to higher NO_3-N in soil. Similarly, variation in hydrolysis of urea for texturally different soils was reported by Kumar and Wagnet (1984).

In Adanur series, the NH4-N content increased upto 3 days, maintained for 7 days and thereafter declined gradually for the application of prilled urea indicating its hydrolysis peak on 3rd day while, for the application of ureagypsum, the peak was reached on 4-5 days gaining delay of 2 days, the reason could be attributed as gypsum inhibited the urease activity which have delayed the urea hydrolysis (Fenn et al., 1981, 1987). In Madukkur series, the hydrolysis of urea proceeded upto 7 days andthereafter a decreasing trend in NH4-N content was observed for urea while ureagypsum only after 9th day. This could be explained as the added gypsum delayed the nitrification of mineralised NH4 -N for about 2 days. The slow hydrolysis could also be explained interms of organic matter content (0.66%) which was low in Madukkar series. Increased activity as stimulated by high organic matter was in line with Fenn et al., (1987).

Increased NO_3 $^-$N of soil observed for progressive stages of quantification could be ascribed to continuous nitrification (Table 4) process under incubated condition. The nitrification rate was higher in Madukkur than in Adanur series favoured the activities of nitrifying bacteria leading to higher NO_3 $^-$N production. Among different sources of N, ureagypsum had resulted in reduced $NO_3$$^-$N owing to the inhibitory effect of Ca on NH_4 transformation under both the soils (Fenn *et al.*, 1987).

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