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EFFECT OF SOILS WITH DIFFERENT CLAY CONTENT ON NITRIFICATION

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The effect of soils with different clay content (15, 25, 35, 45, 55, 61 and 65% clay) on the nitrification of ammonium sulphate, urea and sulfur coated urea added at the rate of 100 ppm N and supplemented with 25 ppm P_2O_5 and K_2O was studied. Control was kept for each soil. Moisture was maintained at field capacity and incubation was done at room temperature. After 24 hours and 7, 21, 35, 49, 63, 77, 94 and 105 days after incubation samples were collected. It was found that increase in the clay content upto 45% increased the nitrification of all the fertilizers and further increase in clay content decreased it. In ammonium sulphate and urea nitrification was completed on 45th day but in sulfur coated urea continued throughout the experiment.

INTRODUCTION

A lot of data are available on the effect of different environmental conditions and soil texture on nitrification, but results are contradictory on the effect of clay content on this process. Rate of nitrification varied with texture of soil and more nitrification was observed in fine than coarse textured soils (Pathak and Shrikhande, 1952; Alexander, 1953; Sabey *et al.*, 1959; and Anderson *et al.*, 1970). Memon (1976) compared the nitrification process of eight soils of Pakistan and observed that NO_3-N production increased with increase in fineness of the soil texture. Contradictory results were reported by Aleem (1950); Wahab *et al.* (1957) and Khurshid (1971). They observed more nitrification in coarse textured soils than fine ones.

Soil texture also influences the NO_3-N production from different fertilizers. Yasin *et al.* (1976) and Synder and Gascho (1976) observed more nitrification in urea than ammonium sulphate and lowest in slow release urea, whereas, Botha (1960) and Prasad (1976) observed less nitrification in urea than ammonium sulphate.

The above mentioned controversy demanded further research and hence the effect of different clay content of soils on nitrification of ammonium sulphate, urea and sulfur coated urea was studied.

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MATERIALS AND METHODS

Seven soils (S_{15}, S_{25} S_{35}, S_{45}, S_{55}, S_{61} and S_{65}) having clay content 15, 25, 35, 45, 55, 61 and 65% respectively were prepared in the laboratory by mixing soils of different clay content. The physical and chemical characteristics are given in table-1.

Procedure : In each plastic container of 1000 g. capacity 400 g soil was taken. Three nitrogen sources i.e., ammonium sulphate (21% N), urea (46% N) and sulfur coated urea (39% N and 20% S) were added at the rate of 100 ppm-N. P_2O_5 and K_2O were added at the rate of 25 ppm to all the containers. Control was kept for each treatment. There were three repeats. Soils were incubated at room temperature and the moisture was kept at field capacity. After 24 hours and 7, 21, 35, 49, 77, 91 and 105 days of incubation soil samples were taken for the determination of NO_3-N, NO_2-N and NH_4-N.

RESULTS AND DISCUSSION

Nitrate production in the soil is highly affected by the texture and other chemical properties of the soil. The analysis of variance for nitrate production from ammonium sulphate, urea, sulfur coated urea and control (no additional nitrogen) as influenced by clay content and time intervals is given in table-2A. The nitrate production under soils of different clay content, when averaged over fertilizers, time intervals and repeats showed highly significant differences. The time intervals averaged over soils, fertilizers and repeats had shown significant differences. Fertilizers and interactions between fertilizers and time intervals were also highly significant. The interactions between soils and times, soils and fertilizers and soils, fertilizers and time intervals were non-significant.

The results averaged over fertilizers, time intervals and repeats are given in table-2B which showed that soils from S_{15} to S_{45} differed significantly from each other and differences among S_{15} and S_{65}, S_{35} and S_{61} and S_{25} and S_{55} were insignificant but S_{25}, S_{61} and S_{65} differed significantly from each other. On average NO_3-N in S_{15} was 52.75 ppm, it increased as the clay content of the soil increased with maximum NO_3-N (99.25 ppm) in S_{45} and as the clay increased further the NO_3-N decreased with the lowest in soil having 65% clay.

The results averaged over soils, fertilizers and repeats (table-2D) showed that with the increase in incubation period the NO_3-N production increased but it was significant upto 35 days and further increase incubation time showed insignificant effect. The results averaged over fertilizers and repeats (table-2) showed that minimum NO_3-N was on one day and maximum on 105 days of incubation. On 7 days of incubation the NO_3-N increased in all the soils with maximum increase in S_{45}, followed in descending order by S_{55}, S_{35}, S_{61} and minimum in S_{65}. On 21 days of incubation the NO_3-N production increased with increase in clay content of the soils upto 45%, and further increase in clay content proportionately decreased the NO_3-N production with minimum in S_{65}. The nitrate nitrogen production as affected by soil clay content followed the same trend throughout the incubation period.

Results presented show that nitrification of urea, ammonium sulphate and sulfur coated urea increased as the clay content increased and maximum nitrate production was in soil having 45% clay. The results are in agreement with the findings of Pathak and Shrikhande (1952); Alexander (1953); Sabey *et al.* (1959); Anderson *et al.* (1970) and Memon (1976). Pathak and Shrikhande (1952) reported that though the three mechanical fractions encouraged the nitrification rate but clay possessed greater nitrifying capacity than silt and sand. According to them the higher nitrifying capacity of clay can be due to greater surface area exposed by finely divided fraction for adsorption of nutrients. Lees and Questel (1946) observed that oxidation of NH_4 took place wholly at the soil surface where NH_4 was adsorbed. Anderson and Purvis (1955) and Smith (1964) reported that soils which had higher cation exchange capacity had higher nitrifying capacity. Base exchange sites had greater influence on the multiplication of ammonifyers as these organisms grow only in the areas formed from NH_4 and soil particles and when these sites were fully occupied by nitrifyers any quantity of NH_4 added nitrified rapidly and without any lag period (Lees and Questel, 1946; Questel and Scholofield, 1951 and Ettinger, 1969).

Results reported show that as the clay content increased over 45% the nitrification rate decreased. More nitrification in coarse textured soils than fine ones was reported (Aleem, 1950 and Wahab *et al.*, 1957). They argued that the higher clay content caused compaction and hence hindred the penetration of oxygen, which disturbed the process of nitrification.

The NO_3-N production from different fertilizers when averaged over soils, time intervals and repeats (table-2C) showed that control differed significantly from all fertilizers; ammonium sulphate and urea slightly and non-significantly with each other, but differed with sulfur coated urea significantly. Maximum NO_3-N was in case of urea, followed by ammonium sulphate, sulfur coated urea and control in decreasing order. Similar results were reported by Yasin *et al.* (1976) and Synder and Gascho (1976). Contradictory results were reported by Botha (1960) and Prasad (1976). They observed less nitrification in urea than ammonium sulphate in three soils and claimed higher losses of NH_3 in urea than ammonium sulphate.

When fertilizer were averaged over soils and repeats (table-4) the amount of NO_3-N on 1 day after incubation was lowest and statistically alike in all treatments. On 7 days of incubation maximum NO_3-N was in case of ammonium sulphate followed by urea, sulfur coated urea and control in decreasing order respectively, but the differences among the fertilizers were insignificant and they also differed with control insignificantly. On 21 days of incubation maximum NO_3-N was in case of urea followed in descending order by ammonium sulphate, sulfur coated urea and control respectively. The increase in NO_3-N in case of ammonium sulphate and urea was comparatively more than sulfur coated urea. On 35 days of incubation NO_3-N further increased, and the increase in control soil and where sulfur coated urea were applied was very slow as compared to ammonium sulfate and urea. On 49 days of incubation the NO_3-N increased in all the fertilizers, with comparatively more increase in sulfur coated urea as compared to other fertilizers where increase was very slight and no increase in control. On 63 days of incubation NO_3-N decreased slightly in control, was constant in urea and ammonium sulphate but increased by 12.5% in sulfur coated urea. On 77, 91 and 105 days of incubation the NO_3-N followed the same trend as observed on 63 days of incubation. It showed that nitrification in control soil, ammonium sulphate and urea was complete on 49 days of incubation, but in case of sulfur coated urea it continued throughout the incubation period.

Table 1. Physical and chemical characteristics of soils used.

Characteristics		Soils						
		S_{15}	S_{25}	S_{35}	S_{45}	S_{55}	S_{61}	S_{65}
Sand	%	72.66	56.56	45.56	35.00	14.56	24.56	15.56
Silt	%	12.00	[illegible]	19.00	20.00	33.00	14.00	18.00
Clay	%	15.44	28.44	35.44	45.00	55.44	61.44	65.44
Saturation	%	23.95	29.19	35.09	33.15	38.83	41.10	45.25
pH		7.7	7.9	7.8	7.9	7.9	8.0	7.9
$CaCo_3$	%	5.35	5.40	6.03	6.70	6.30	6.49	6.79
CEC me/100g		5.4	7.5	10.3	14.4	11.4	11.4	11.5
O.M.		0.69	0.87	1.14	1.18	1.13	1.14	0.67
$EC_e \times 10^3$		2.9	3.3	4.0	4.7	2.0	1.8	1.4
Total-N	%	0.031	0.004	0.056	0.064	0.056	0.056	0.033
NH_4-N (ppm)		35.5	40.0	46.5	53.25	43.25	49.00	42.00
NO_2-N (ppm)		nil	nil	nil	nil	nil	nil	nil
NO_3-N (ppm)		22.0	24.27	34.50	41.75	48.00	[illegible]	22.00
Available P (ppm)		2.6	6.0	8.0	8.5	6.4	8.0	7.0
Exch. Na (me/100g)		2.26	3.38	4.32	5.55	3.48	4.26	2.27
„ K („ „)		0.26	0.37	1.00	1.85	0.66	0.59	0.49
ESP		41.8	45.1	41.9	38.5	30.5	37.4	49.7

Table 2A. *Analysis of variance for NO_3-N produced by various fertilizers in soils of different clay content on different incubation times.*

Source of variance	D.F.	S.S.	M.S.	F. Ratio	S.E.
R	2	841.17			
F	3	285343.18	95114.39	136.09**	1.92
S	6	204066.09	34011.02	48.65**	2.55
D	8	384414.38	48051.80	68.47**	2.88
F x S	18	9019.35	501.08	0.72 NS	
F x D	24	105621.71	4400.90	6.30**	5.77
S x D	48	17355.60	361.58	0.50NS	
SxDxF	144	5374.01	37.32	0.05NS	
E	502	350921.83	699.05		

Table 2B. *Comparison among soils averaged over fertilizers, incubation times and repeats (NO_3-N ppm).*

S_{15}	S_{25}	S_{35}	S_{45}	S_{55}	S_{61}	S_{69}*
52.75a	66.33b	82.87c	99.25d	73.25b	80.25c	48.44a

Table 2C. *Comparison among fertilizers averaged over soils, time intervals and repeats (NO_3-N ppm).*

Control	Sulfur coated urea	Ammonium sulphate	Urea*
39.73a	73.33b	86.44c	88.06c

Table 2D. *Comparison among time intervals averaged over soils, fertilizers and repeats (NO_3-N ppm).*

D_1	D_7	D_{21}	D_{35}	D_{49}	D_{63}	D_{77}	D_{91}	D_{105}*
28.68a	39.18b	57.89c	79.14d	84.79de	87.64e	88.85e	89.79e	91.09e

* = Figures carrying the same letter are not statistically different from each other (P = 0.05).

Table 3. *NO_3-N (ppm) production from various fertilizers as influenced by soils having different clay content (results are averaged over fertilizers and repeats).*

Soil	DAYS								
	1	7	21	35	49	63	77	91	105
S_{15} (15% clay)	22.25	28.00	41.75	87.75	63.00	64.70	65.00	65.00	67.00
S_{25} (25% clay)	24.00	34.75	51.75	73.00	78.00	81.00	80.79	82.58	85.50
S_{35} (35% clay)	35.00	48.75	68.25	91.50	96.50	99.75	100.85	102.00	103.25
S_{45} (45% clay)	42.25	59.75	84.75	111.50	117.00	119.75	120.00	119.50	119.50
S_{55} (55% clay)	18.25	33.00	59.25	84.50	88.75	92.25	93.75	94.25	95.25
S_{61} (61% clay)	38.00	46.00	63.50	84.00	94.00	96.75	97.33	100.75	102.30
S_{65} (65% clay)	21.89	24.50	36.00	51.25	56.25	59.00	61.25	62.00	64.75

Table 4. *NO_3-N (ppm) production from various nitrogenous fertilizers on different time intervals (results are averaged over soils and repeats).*

Fertilizers	DAYS									
	1	7	21	35	49	63	77	91	106
Control	28.57a	35.14a	40.57a	43.14a	43.14a	42.86a	41.18a	41.43a	40.90a
Ammonium sulphate	28.57a	41.71a	64.43bc	103.00c	107.00c	107.86c	107.57b	106.71b	107.71b
Urea	29.00a	40.86a	70.00c	105.43c	109.00c	110.00c	110.00b	108.71b	110.00b
Sulfur coated urea	28.57a	39.00a	52.57ab	66.00b	80.00b	89.86b	96.00b	102.29b	105.71b

Figures carrying the same letter are not significantly different from each other (P=0.05).

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