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Study of Nitrogen Fractions in Soils of Osmanabad District of Marathawada

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Abstract: The present investigation was carried out to “study Nitrogen fractions in soils of Osmanabad district of Marathawada”. For this purpose 180 representative soil samples were collected from 30 villages of Tuljapur tahsil. The collected soil samples were grouped into three orders *viz.* Vertisols, Inceptisols and Entisols. Out of the total surveyed soil samples, 34 per cent samples were grouped under Vertisols while, 47 per cent and 19 per cent samples were grouped under Inceptisols and Entisols, respectively and orderwise analysis was carried out. In chemical analysis, the soils under study area were alkaline in reaction, safe in limit of electrical conductivity and moderately calcareous to calcareous in nature. The organic carbon content in soils was found low to medium. The soils were found to be low in all the fractions of N *viz.* total N, available N, total hydrolysable N, amino acid N, acid insoluble N, ammonical N and nitrate N. The pH and CaCO₃ showed negative and significantly correlated with all the fractions of nitrogen in Inceptisols and Entisols. Whereas, organic carbon showed positive and significant correlation with different fractions of nitrogen in all soil orders. However, electrical conductivity showed negative and significant correlation with all the fractions of N except total N in Vertisols and EC did not showed any relation with N fractions in Inceptisols and Entisols under study.

Key words: N fractions, soil properties, Vertisols, Inceptisols and Entisols.

INTRODUCTION

Osmanabad district is located between 18° 28' to 19° 28' North altitude and 76° 25' to 77° 25' East latitude. The geographical area of the district is

7512.40 sq. km. Osmanabad district is the South western part of Marathwada region of Maharashtra state with annual rainfall 769 mm. Maximum and minimum temperature of this district is 43.3°C and

11.9°C, respectively. The elevation is 725-750 m from mean sea level and which comes under Central Maharashtra Plateau Agro-climatic Zone and Semi-arid region. Osmanabad district comprises 8 tahsil, out of these Tuljapur tahsil is considered for the study. The chemical characteristics like, pH, EC, organic carbon and calcium carbonate are important as these affect on availability of nutrients in soil and thereby on crop growth and production. The soil must supply the nutrients that are essential for plant growth and necessary component of human and animal food for sustainable agriculture. The total nitrogen in soil generally varies from 0.02 to 0.44 per cent and its per cent of clayey soil of Maharashtra is 0.045. The total nitrogen content of the soil depends on several factors like soil type, texture, soil pH, soil Eh, climate, topography, vegetation, and fertilizer management. Nitrogen in soil exists in two major forms *i.e.* organic and inorganic nitrogen. 98 per cent total nitrogen is present in the organic form and only about 2 per cent in inorganic form. The inorganic form is liable to be lost through different types of losses like run off, ammonia volatilization, leaching, denitrification and fixation by clay minerals.

The organic form of nitrogen, mainly the hydrolysable form is slowly mineralized and is transformed to minerals nitrogen through ammonization, ammonification and nitrification processes and made available to crops. Nitrogen is necessary for life however, it is ironic that more than 99 per cent of the N exists as N₂ in the atmosphere and is not available to > 99 per cent of living organisms. Nitrogen is the most important mineral nutrient for crop production and its adequate supply in the soil in different forms, which roots can take up is essential for high yields. Until recent times, specialized abilities of certain types of microbes living in the soil and lightning strikes are the only ways to convert N₂ molecules to reactive N forms (the process is called fixation) which made their way from the environment into living organisms. Plants turn this fixed N into organic nitrogen—the form combined with carbon (C) in a wide variety of

molecules essential both to plants and animals that will eat them. The N cycle gets completed through the process of denitrification, in which organisms use reactive forms of N such as nitrate as their energy source and return N₂ molecules to the atmosphere (Singh and Singh, 2009). Organic N forms can be fractionated into amino acid, amino sugars, hydrolysable NH₄-N, unidentified and non hydrolysable-N. Out of these, amino acid and amino sugars are of microbial origin and influenced by changes in microbial activity. Trees may differentially influence organic fractions of N in soil and also losses from applied urea. Crops are reported to display preference for specific N fraction to meet their N requirement *e.g.* pearl millet for amino acid and hydrolysable NH₄, while rice and wheat for amino acid and amino sugars. Therefore, it is hypothesized that in desirable agroforestry systems companion tree species shall enrich N fraction preferred by companion crops, and reduce delay period of nitrification. (Burman *et al.*, 2002)

MATERIALS AND METHODS

Geography and climate of Osmanabad district, Soils of Osmanabad district, Selection of site or location, Collection of soil samples, Preparation of soil samples

Chemical Properties of Soil

Soil pH, EC, Organic carbon, Calcium carbonate.

Nitrogen Fractions in Soils

Available nitrogen, Total nitrogen, Total hydrolysable nitrogen, Amino acid nitrogen, Acid insoluble nitrogen, Ammonical nitrogen, Nitrate nitrogen

Statistical Analysis

Materials

Geography and climate of Osmanabad District

Osmanabad district is located between 18° 28' to 19° 28' North altitude and 76° 25' to 77° 25' East latitude.

The geographical area of the district is 7512.40 sq. km. Osmanabad district is the South western part of Marathwada region of Maharashtra state. Annual rainfall is 769 mm. Maximum and minimum temperature of this district is 43.3°C and 11.9°C, respectively. The elevation is 725-750 m from mean sea level and which comes under Central Maharashtra Plateau Agro-climatic Zone and Semi- arid Region.

Soils of Osmanabad District

Soils of Osmanabad district mostly belongs to order Vertisols, Inceptisols and Entisols. The soils were varied in colour due to presence of different types of minerals like plagioclase, augite, calcite, dolomite, magnetite *etc.* The soils in the area vary widely in both texture and depth. The soils of the area are rough and rocky largely consisting of basalt. Thin deposits of fertile black soil are found in the northern part and in the South at the western region. Most of the land of the district is full of rock and thin layers of soil except Kumbhari, Kilaj, Masala, Hangarga and Kathi where the land consists of rich fertile black cotton soil.

Selection of Site or Location

Tuljapur tahsil consist of 109 villages, out of these 30 villages were selected for this study. The villages were selected randomly in such way that it should cover whole area of the tahsil. The selected villages from Tuljapur tahsil of Osmanabad district were Kakramba, Khandala, Wadgaodev, Kilaj, Horti, Jalkot, Hangarga, Sindhagao, Lohgao, Sindhafal, Masala, Kati, Jalkotwadi, Wadgao, Suratgao, Pinpala, Devkurali, Dhatri, Eatkal, Nilegao, Gujnur, Khumbhari, Nanduri, Vasantvadi, Chivari, Andur Tirthbuduruk, Aapsinga, Kamtha, Mardi for collection of soil samples.

Collection of Soil Samples

In order to study the fertility status of soils from Tuljapur tahsil of Osmanabad district, six soil samples were collected from each village. One

hundred and eighty representative surface (0-20 cm) soil samples were collected. The soils were grouped into different orders according to USDA classification.

Preparation of Soil Samples

Soil samples collected from different villages of Tuljapur tahsil were brought to the laboratory, thoroughly mixed, air dried in shade, ground with wooden mortar and pestle and passed through 2 mm sieve. The sieved soil samples were stored in cloth bags/polythene bags with proper labeling for subsequent analysis. All the precautions outlined by Jackson (1973) were scrupulously followed in order to avoid contamination.

Methodology

The standard methods were followed for determination of physico-chemical properties and forms of N in soils which are given below.

Soil pH

It was determined in soil: water suspension (1:2.5) using glass electrode pH meter (Jackson, 1973).

Electrical conductivity

It was estimated from supernatant solution of soil water suspension (1:2.5) by using conductivity bridge (Jackson, 1973).

Organic carbon

Modified method of Walkley and Black (1934) was used for determination of organic carbon.

Calcium carbonate

Free calcium carbonate was determined with rapid titration method as outlined by Piper (1966).

Nitrogen Fractions

Available nitrogen

It was analyzed by alkaline potassium permanganate method as suggested by Subbiah and Asija (1956).

Total nitrogen

Total nitrogen from soil samples was estimated by micro kjeldhal method as described by Page *et al.* (1989).

Total hydrolysable nitrogen

It was estimated by steam distillation method as suggested by Bremner (1965).

Amino acid nitrogen

It was estimated by steam distillation method as described by Bremner (1965).

Acid insoluble nitrogen

It was analyzed by steam distillation method as described by Bremner (1965).

Ammonical nitrogen

It was evaluated by steam distillation method as suggested by Bremner (1965).

Nitrate nitrogen

It was evaluated by steam distillation method as suggested by Bremner (1965).

RESULTS AND DISCUSSION

In order to determine the nitrogen fractions of the soils from Tuljapur tahsil of Osmanabad district, one hundred and eighty representative surface soil samples were collected from different villages. The collected soil samples were grouped into three orders. 34 per cent soil samples were grouped under the order Vertisol while, 47 per cent and 19 per cent soil samples were grouped under the order Inceptisol and Entisol, respectively.

Status of Nitrogen Fractions in Vertisols

The data regarding status of nitrogen fractions in Vertisols are presented in Table 1. The results indicated that among the different nitrogen fractions,

total nitrogen varied in the range of 0.039 to 0.100 per cent with a mean value of 0.069 per cent (Table 1). Maximum value was observed in soils (No. 129) collected from the village Kumbhari and it was minimum in soils collected (No. 62, 65) from Masala and (No. 102) Devkurali villages. Available nitrogen (Table 6) showed the minimum value in the soils (No. 119) collected from Nilegao village while, the maximum in soils (No. 102) collected from Devkurali village. It is seen from the data (Table 1), available nitrogen ranged from 106.6 to 404.5 kg ha⁻¹ with an average value of 189.0 kg ha⁻¹. Total hydrolysable nitrogen varied in the range of 292.00 to 750.00 mg kg⁻¹ with a mean value of 531.18 mg kg⁻¹ (Table 1). Maximum value was observed in soils (No. 129) from the village Kumbhari and it was minimum in soils (No. 65) collected from Masala village.

Further data revealed that amino acid N in Vertisols ranged from 136.50 to 350.00 mg kg⁻¹ with an average of 244.61 mg kg⁻¹ (Table 1). The maximum value was observed in soils (No. 129) from the Kumbhari village while, the minimum value was observed in soils (No. 62 and 65) collected from Masala and (No. 102) Devkurali villages. Acid insoluble nitrogen was ranged between 90 to 250 mg kg⁻¹ with a mean value 167.65 mg kg⁻¹ (Table 1). The highest value was noted in soils (No. 129) collected from Kumbhari village and it was lowest in soils (No. 102) collected from Devkurali village in Vertisols. Among the nitrogen fractions, ammonical nitrogen varied in the range of 14.04 to 36 mg kg⁻¹ with a mean value of 25.16 mg kg⁻¹ (Table 9). The highest value was observed in soils (No. 129) collected from Kumbhari village and the lowest value observed in soils (No. 62, 65) collected from masala and (No. 102) Devkurali villages. Nitrate nitrogen ranged from 5.85 to 15.00 mg kg⁻¹ with a mean value of 10.48 mg kg⁻¹ (Table 1). The highest value was found in soils (No. 129) collected from Kumbhari village and the lowest value was found in soils (No. 62, 65) collected from Masala and (No. 102) Devkurali villages in vertisols.

Table 1
Status of nitrogen fractions in Vertisols

<i>Sr. No.</i>	<i>Sample No.</i>	<i>Total N (%)</i>	<i>Available N (kg ha⁻¹)</i>	<i>Total hydrolysable N (mg kg⁻¹)</i>	<i>Amino acid N (mg kg⁻¹)</i>	<i>Acid insoluble N (mg kg⁻¹)</i>	<i>Ammonical N (mg kg⁻¹)</i>	<i>Nitrate N (mg kg⁻¹)</i>
1.	4	0.049	225.8	367.50	171.50	122.50	17.64	7.35
2.	7	0.058	207.0	440.80	203.00	139.20	20.88	8.70
3.	13	0.079	116.0	608.30	276.50	181.70	28.44	11.85
4.	15	0.070	194.4	546.00	245.00	154.00	25.20	10.50
5.	19	0.086	178.8	645.00	301.00	215.00	30.96	12.90
6.	20	0.081	172.5	615.60	283.50	194.40	29.16	12.15
7.	24	0.077	188.2	577.50	269.50	192.50	27.72	11.55
8.	27	0.044	166.2	330.00	154.00	110.00	15.84	6.60
9.	29	0.040	288.5	308.00	140.00	92.00	14.40	6.00
10.	35	0.043	163.1	331.10	150.50	98.90	15.48	6.45
11.	37	0.053	131.7	402.80	185.50	127.20	19.08	7.95
12.	38	0.056	153.7	436.80	196.00	123.20	20.16	8.40
13.	40	0.058	279.1	446.60	203.00	133.40	20.88	8.70
14.	41	0.071	185.0	553.80	248.50	156.20	25.56	10.65
15.	58	0.047	207.0	352.50	164.50	117.50	16.92	7.05
16.	59	0.044	194.4	343.20	154.00	96.80	15.84	6.60
17.	60	0.059	153.7	442.00	206.50	148.00	21.24	8.85
18.	62	0.039	225.8	292.50	136.50	97.50	14.04	5.85
19.	63	0.043	194.4	322.50	150.50	107.50	15.48	6.45
20.	65	0.039	213.2	292.00	136.50	98.00	14.04	5.85
21.	66	0.085	194.4	637.50	297.50	212.50	30.60	12.75
22.	68	0.088	153.7	704.00	308.00	176.00	31.68	13.20
23.	70	0.095	203.8	712.50	332.50	237.50	34.20	14.25
24.	71	0.091	194.4	680.50	318.50	229.50	32.76	13.65
25.	72	0.084	207.0	630.00	294.00	210.00	30.60	12.60
26.	76	0.078	147.4	585.00	273.00	195.00	28.08	11.70
27.	78	0.077	163.1	577.50	269.50	192.50	27.72	11.55
28.	81	0.072	178.8	540.00	252.00	180.00	25.92	10.80
29.	83	0.071	216.4	532.50	248.50	175.50	25.56	10.65
30.	84	0.058	194.4	464.00	203.00	116.00	20.88	8.70
31.	87	0.050	257.2	375.00	175.00	125.00	18.00	7.50
32.	94	0.053	116.0	397.50	185.50	132.50	19.08	7.95
33.	95	0.057	272.8	427.50	199.50	142.50	20.52	8.55
34.	98	0.044	250.9	334.40	154.00	105.60	15.84	6.60

Contd. Table 1

Sr. No.	Sample No.	Total N (%)	Available N (kg ha ⁻¹)	Total hydrolysable N (mg kg ⁻¹)	Amino acid N (mg kg ⁻¹)	Acid insoluble N (mg kg ⁻¹)	Ammonical N (mg kg ⁻¹)	Nitrate N (mg kg ⁻¹)
35.	99	0.075	257.2	562.50	262.50	187.50	27.00	11.25
36.	102	0.039	404.5	300.00	136.50	90.00	14.04	5.85
37.	105	0.049	163.1	392.00	171.50	98.00	17.64	7.35
38.	111	0.051	131.7	408.00	178.00	102.00	18.36	7.65
39.	117	0.063	116.0	472.50	220.50	157.50	22.68	9.45
40.	118	0.065	131.7	487.50	228.00	162.50	23.40	9.75
41.	119	0.072	106.6	540.00	252.00	180.00	25.92	10.80
42.	123	0.086	178.8	645.00	301.00	215.00	30.96	12.90
43.	128	0.095	172.5	712.50	332.50	237.50	34.20	14.25
44.	129	0.100	288.5	750.00	350.00	250.00	36.00	15.00
45.	130	0.099	194.4	742.50	346.00	247.50	35.64	14.85
46.	131	0.098	185.0	735.00	343.00	245.00	35.28	14.70
47.	132	0.093	156.8	697.50	325.50	232.50	33.48	13.95
48.	133	0.089	172.5	667.50	312.00	222.50	32.04	13.35
49.	136	0.091	219.5	682.50	319.00	227.50	32.76	13.65
50.	137	0.085	216.4	637.50	297.50	212.50	30.60	12.75
51.	139	0.063	216.4	504.00	220.00	126.00	22.68	9.45
52.	144	0.058	131.7	464.00	203.00	116.00	20.88	8.70
53.	151	0.098	178.8	735.00	343.00	245.00	35.28	14.70
54.	161	0.084	153.7	630.00	294.00	210.00	30.24	12.60
55.	165	0.072	134.8	576.00	252.00	144.00	25.92	10.80
56.	166	0.067	216.4	536.00	234.50	134.00	24.12	10.05
57.	168	0.081	213.2	607.50	283.50	202.50	29.16	12.15
58.	172	0.086	153.7	645.00	301.00	215.00	30.96	12.90
59.	174	0.077	213.2	616.00	269.50	154.00	27.72	11.55
60.	176	0.079	156.8	592.50	276.50	197.50	28.44	11.85
61.	178	0.095	116.0	712.50	333.00	237.50	34.20	14.25
62.	180	0.084	150.5	630.00	294.00	210.00	30.24	12.60

Status of Nitrogen Fractions in Inceptisols

The data pertaining to status of nitrogen fractions in Inceptisols are presented in table 2.

The results showed that total nitrogen varied from 0.0252 to 0.0896 per cent with a mean value of 0.0583 per cent (Table 2). Maximum value was recorded in soils (No. 12, 120, 159) from the villages Khandala, Nilegao and Tirtha and it was minimum

in soils (No. 39, 43 and 79) collected from Hangarga, Sindagao and Wadgao villages. Available N in soils ranged from 90.9 to 373.1 kg ha⁻¹ with an average of 192.1 kg ha⁻¹. The lowest amount of available nitrogen was found in soils (No.17) of Wadgao village while, the highest amount of available nitrogen was observed in soils (No.148) collected from the village Chiwari.

Table 2
Status of nitrogen fractions in Inceptisols

<i>Sr. No.</i>	<i>Sample No.</i>	<i>Total N (%)</i>	<i>Available N (kg ha⁻¹)</i>	<i>Total hydrolysable N (mg kg⁻¹)</i>	<i>Amino acid N (mg kg⁻¹)</i>	<i>Acid insoluble N (mg kg⁻¹)</i>	<i>Ammonical N (mg kg⁻¹)</i>	<i>Nitrate N (mg kg⁻¹)</i>
1.	1	0.0392	163.1	294.00	136.50	98.00	14.04	5.85
2.	2	0.049	225.8	367.50	171.50	122.50	17.64	7.35
3.	3	0.0658	210.1	493.50	227.50	164.50	23.40	9.75
4.	5	0.056	159.9	420.00	196.00	140.00	20.16	8.40
5.	6	0.0812	150.5	609.00	284.20	203.00	29.16	12.15
6.	8	0.0868	194.4	651.00	303.80	217.00	30.96	12.90
7.	9	0.0728	194.4	546.00	252.00	182.00	26.20	10.80
8.	10	0.0686	138.0	514.50	238.00	171.50	24.48	10.20
9.	12	0.0896	213.2	672.00	311.50	224.00	32.04	13.35
10.	16	0.0308	156.8	246.40	105.00	61.60	10.80	4.50
11.	17	0.0784	90.9	585.00	273.00	199.00	28.08	11.70
12.	21	0.0266	178.8	202.16	91.00	63.84	9.36	3.90
13.	22	0.0294	225.8	229.32	101.50	64.68	10.44	4.35
14.	23	0.0644	172.5	480.00	224.00	164.00	23.04	9.60
15.	25	0.0868	213.2	651.00	301.00	217.00	30.96	12.90
16.	26	0.0504	150.5	378.00	175.00	126.00	18.00	7.50
17.	30	0.0854	247.7	640.50	297.50	213.50	30.60	12.75
18.	31	0.0574	153.7	430.50	199.50	143.50	20.52	8.55
19.	32	0.0714	178.8	535.50	248.50	178.50	25.56	10.65
20.	34	0.0588	319.9	441.00	205.80	147.00	20.88	8.70
21.	36	0.0476	203.8	361.70	164.50	114.30	16.92	7.05
22.	39	0.0252	241.5	192.00	87.50	60.00	9.00	3.75
23.	42	0.0336	153.7	262.00	117.60	74.00	11.88	4.95
24.	43	0.0252	276.0	190.00	87.50	62.00	9.00	3.75
25.	44	0.048	285.4	369.60	168.00	110.40	17.28	7.20
26.	45	0.0602	244.6	451.50	210.00	150.50	21.60	9.00
27.	49	0.028	112.9	215.60	98.00	64.40	10.08	4.20
28.	51	0.0308	131.7	234.00	105.00	74.00	10.80	4.50
29.	55	0.056	213.2	425.60	196.00	134.40	20.16	8.40
30.	56	0.042	222.7	327.60	147.00	92.40	15.12	6.30
31.	57	0.070	244.6	525.00	245.00	175.00	25.20	10.50
32.	61	0.0462	178.8	358.80	161.00	103.20	16.56	6.90
33.	64	0.0742	238.3	555.00	259.00	187.00	26.64	11.10
34.	67	0.0812	216.4	609.00	283.50	203.00	29.16	12.15

Contd. Table 2

Sr. No.	Sample No.	Total N (%)	Available N (kg ha ⁻¹)	Total hydrolysable N (mg kg ⁻¹)	Amino acid N (mg kg ⁻¹)	Acid insoluble N (mg kg ⁻¹)	Ammonical N (mg kg ⁻¹)	Nitrate N (mg kg ⁻¹)
35.	69	0.084	172.5	630.00	294.00	210.00	30.24	12.60
36.	73	0.0658	203.8	487.50	227.50	170.50	23.40	9.75
37.	74	0.0882	241.5	660.00	308.00	222.00	31.68	13.20
38.	75	0.0742	178.8	555.00	259.00	187.00	26.64	11.10
39.	79	0.0252	335.6	192.00	87.50	60.00	9.00	3.75
40.	80	0.0322	147.4	249.60	112.00	72.40	11.52	4.80
41.	82	0.0672	241.5	504.00	234.50	168.00	24.12	10.05
42.	91	0.0630	169.3	472.50	220.50	157.50	22.68	9.45
43.	96	0.0868	185.0	645.00	301.00	223.00	30.96	12.90
44.	97	0.0616	288.5	462.00	213.50	154.00	21.96	9.15
45.	100	0.0252	191.3	192.00	87.50	60.00	9.00	3.75
46.	101	0.0280	131.7	218.40	98.00	61.60	10.08	4.20
47.	106	0.049	156.8	372.40	171.50	117.60	17.64	7.30
48.	107	0.042	178.8	327.60	147.00	92.40	15.12	6.30
49.	110	0.0882	163.1	661.50	308.00	220.50	31.68	13.20
50.	112	0.0798	203.8	592.50	276.50	205.50	28.44	11.85
51.	114	0.0714	178.8	556.90	248.50	157.10	25.56	10.65
52.	115	0.0294	163.1	229.30	101.50	64.70	10.44	4.35
53.	116	0.0812	172.5	609.00	284.00	203.00	29.16	12.15
54.	120	0.0896	147.4	672.00	311.50	224.00	32.04	13.35
55.	121	0.0378	185.0	302.40	130.00	75.60	13.32	5.55
56.	122	0.056	175.6	436.80	196.00	123.20	20.16	8.40
57.	124	0.0406	169.3	320.00	142.10	86.00	14.40	6.00
58.	126	0.084	178.8	630.00	294.00	210.00	30.24	12.60
59.	127	0.042	203.8	336.00	147.00	84.00	15.12	6.30
60.	134	0.063	241.5	491.40	220.50	138.60	22.68	9.45
61.	135	0.063	194.4	504.00	220.50	126.00	22.68	9.45
62.	138	0.0644	188.2	480.00	224.00	164.00	23.04	9.60
63.	140	0.0504	257.2	394.00	175.00	110.00	18.00	7.50
64.	142	0.084	159.9	630.00	294.00	210.00	30.24	12.60
65.	145	0.0784	134.8	585.00	273.00	199.00	28.08	11.70
66.	147	0.0756	194.4	570.00	263.00	186.00	27.00	11.25
67.	148	0.0294	373.2	223.40	102.90	70.60	10.44	4.35
68.	149	0.0448	147.4	330.00	154.00	118.00	15.84	6.60
69.	152	0.0476	194.4	357.20	164.50	118.80	16.92	7.05
70.	153	0.0252	185.0	192.00	87.50	60.00	9.00	3.75

Contd. Table 2

Study of Nitrogen Fractions in Soils of Osmanabad District of Marathwada

<i>Sr. No.</i>	<i>Sample No.</i>	<i>Total N (%)</i>	<i>Available N (kg ha⁻¹)</i>	<i>Total hydrolysable N (mg kg⁻¹)</i>	<i>Amino acid N (mg kg⁻¹)</i>	<i>Acid insoluble N (mg kg⁻¹)</i>	<i>Ammonical N (mg kg⁻¹)</i>	<i>Nitrate N (mg kg⁻¹)</i>
71.	154	0.0280	116.0	218.40	98.00	61.60	10.08	4.20
72.	155	0.0266	153.7	202.10	91.00	63.90	9.36	3.90
73.	158	0.0868	147.4	645.00	301.00	223.00	30.96	12.90
74.	159	0.0896	213.2	667.50	311.50	228.50	32.04	13.35
75.	163	0.0812	188.2	609.00	284.20	203.00	29.16	12.15
76.	164	0.0588	116.0	446.60	203.00	141.40	20.88	8.70
77.	167	0.0840	163.1	630.00	294.00	210.00	30.24	12.60
78.	169	0.0714	213.2	532.50	248.50	181.50	25.56	10.65
79.	170	0.0532	203.8	413.40	185.50	118.60	19.08	7.95
80.	171	0.0574	194.4	427.50	200.00	146.50	20.52	8.55
81.	173	0.0882	216.4	660.00	308.00	222.00	31.68	13.20
82.	175	0.0406	163.1	320.00	140.00	86.00	14.40	6.00
83.	177	0.0420	178.8	336.00	147.00	84.00	15.12	6.30
84.	179	0.056	134.8	448.00	196.00	112.00	20.16	8.40

Among the different nitrogen fractions, Total hydrolysable nitrogen varied in the range of 190.00 to 672.00 mg kg⁻¹ with a mean value of 441.56 mg kg⁻¹ (Table 2). The highest value was recorded in soils (No. 12 and 120) collected from the villages Khandala and Nilegao and it was lowest in soils (No. 43) collected from Sindagao village. The data further revealed that amino acid N in Inceptisols ranged from 87.50 to 311.50 mg kg⁻¹ with a mean value of 203.09 mg kg⁻¹ (Table 2). The maximum value was observed in soils (No. 12) collected from the Khandala village while, it was minimum in soils (No. 39 and 79) collected from Hangarga and Wadgao villages. Acid insoluble nitrogen was ranged between 60 to 228.50 mg kg⁻¹ with an average 141.64 mg kg⁻¹ (Table 2). The highest value was recorded in soils (No. 159) collected from Tirtha village and lowest values were observed in soils (No. 39, 79 and 153) collected from Hangarga, Wadgao and Andur villages under Inceptisols.

Ammonical nitrogen varied in the range of 9.00 to 32.04 mg kg⁻¹ with a mean value of 20.87 mg kg⁻¹ (Table 2). The highest value noted in soils (No. 12 and 120) collected from Khandala and Nilegao

villages and the lowest value noted in soils (No. 39 and 79) collected from Hangarga and Wadgao villages. Nitrate nitrogen ranged from 3.75 to 13.35 mg kg⁻¹ with a mean value of 8.69 mg kg⁻¹. The maximum values were observed in soils (No. 12 and 120) collected from Khandala and Nilegao villages and it was minimum in soils (No. 39 and 43) collected from Hangarga and Sindagao villages under Inceptisols.

Status of Nitrogen Fractions in Entisols

The data on status of nitrogen fractions in Entisols are presented in table 3. The data indicated that among the different nitrogen fractions, total nitrogen varied between 0.021 to 0.081 per cent with a mean value of 0.059 per cent (Table 3). Maximum value was observed in soils (No. 48) from the village Sindafaland minimum in soils (No. 86) collected from Suratgao village. Available N in these soils ranged from 100.4 to 276.00 kg ha⁻¹ with an average value of 184.57 kg ha⁻¹. The lowest available nitrogen was recorded in the soils (No. 109) of Etkal village and it was the highest in soils (No. 33) collected from Jalkot village. Total hydrolysable nitrogen varied from

Table 3
Status of nitrogen fractions in Entisols

<i>Sr. No.</i>	<i>Sample No.</i>	<i>Total N (%)</i>	<i>Available N (kg ha⁻¹)</i>	<i>Total hydrolysable N (mg kg⁻¹)</i>	<i>Amino acid N (mg kg⁻¹)</i>	<i>Acid insoluble N (mg kg⁻¹)</i>	<i>Ammonical N (mg kg⁻¹)</i>	<i>Nitrate N (mg kg⁻¹)</i>
1.	11	0.039	191.3	294.00	136.50	98.00	14.11	5.85
2.	14	0.049	225.8	367.50	171.50	122.50	17.64	7.35
3.	18	0.058	156.8	441.00	205.80	147.00	20.88	8.70
4.	28	0.067	178.8	524.16	235.20	147.84	24.12	10.05
5.	33	0.057	276.0	459.20	200.90	114.80	20.52	8.55
6.	46	0.070	178.8	525.00	245.00	175.00	25.20	10.50
7.	47	0.077	216.4	577.50	269.50	192.50	27.72	11.55
8.	48	0.081	213.2	633.36	284.20	178.64	29.16	12.15
9.	50	0.068	241.5	548.80	238.00	137.20	24.48	10.20
10.	52	0.074	178.8	556.50	259.00	185.50	26.64	11.10
11.	53	0.065	147.4	520.00	227.50	138.00	23.40	9.75
12.	54	0.072	141.1	546.00	254.80	182.00	25.92	10.80
13.	77	0.079	172.5	598.50	276.50	199.50	28.44	11.85
14.	85	0.067	213.2	524.16	235.20	147.84	24.12	10.05
15.	86	0.021	185.0	157.50	73.50	52.50	7.56	3.15
16.	88	0.028	188.2	210.00	98.00	70.00	10.08	4.20
17.	89	0.042	185.0	327.60	147.00	92.40	15.12	6.30
18.	90	0.057	163.1	430.50	199.50	143.50	20.52	8.55
19.	92	0.060	216.4	457.50	210.00	144.50	21.60	9.00
20.	93	0.071	178.8	560.90	249.90	153.10	25.56	10.65
21.	103	0.078	175.6	585.00	273.00	199.00	28.08	11.70
22.	104	0.072	188.2	553.20	254.80	174.80	25.92	10.80
23.	108	0.053	116.0	425.60	185.50	106.40	19.08	7.95
24.	109	0.043	100.4	344.00	151.90	90.00	15.48	6.45
25.	113	0.040	210.1	304.50	142.10	101.50	14.40	6.00
26.	125	0.026	153.7	195.00	91.00	71.00	9.36	3.90
27.	141	0.078	247.7	585.00	273.00	199.00	28.08	11.70
28.	143	0.070	147.4	525.00	245.00	175.00	25.20	10.50
29.	146	0.071	122.3	560.90	249.90	153.10	25.56	10.65
30.	150	0.064	210.1	480.00	225.40	164.00	23.04	9.60
31.	156	0.050	194.4	393.12	175.00	110.88	18.00	7.50
32.	157	0.033	181.9	252.00	117.60	84.00	11.88	4.95
33.	160	0.056	216.4	420.00	196.00	140.00	20.16	8.40
34.	162	0.074	163.1	556.50	259.70	185.50	26.64	11.10

157.50 to 633.36 mg kg⁻¹ with a mean value of 454.10 mg kg⁻¹ (Table 3). Maximum value was noted in soils (No. 48) from the village Sindafal and it was minimum in soils (No. 86) collected from Suratgao village.

Further data showed that amino acid N in Entisols ranged from 73.50 to 284.20 mg kg⁻¹ with a mean value of 207.57 mg kg⁻¹ (Table 3). The maximum value was showed in soils (No. 48) from the Sindafal village while, it was minimum in soils (No. 86) collected from Suratgao village. Acid insoluble nitrogen was ranged from 52.50 to 199.50 mg kg⁻¹ with a mean value 140.48 mg kg⁻¹ (Table 3). The highest value was found in soils (No. 48) collected from Sindafal village and it was the lowest in soils (No. 86) collected from Suratgao village in Entisols. Ammonical nitrogen varied in the range of 7.56 to 29.16 mg kg⁻¹ with a mean value of 21.28 mg kg⁻¹.

CONCLUSION

All fractions of nitrogen were found to be low in study area. All the nitrogen fractions showed negative and significant correlation with pH and CaCO₃ in Inceptisols and Entisols. In Vertisols pH, EC and CaCO₃ showed negative and significantly correlated with all the fractions of nitrogen except total N which is not significant with EC while, organic carbon showed positively significant correlation with all fractions of N in Vertisols, Inceptisols and Entisols.

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