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Assessment of different nitrogen forms in soilorders viz. vertisols, Inceptisols and Entisols in Marathwada region

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Abstract
The present investigation was carried out to study assessment of different nitrogen forms in soils of Tuljapur Tehsil of Osmanabad district. For this purpose 180 representative soil samples were collected from 30 villages of Tuljapur Tehsil. 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 in all three orders *viz.* Vertisols, Inceptisols and Entisols.

Keywords: Assessment, different nitrogen forms, soilorders viz. vertisols, inceptisols, Entisols

Introduction
Marathwada region of Maharashtra state occupies 64 lakh ha area and lies between $17^0$35' to 20^0 40' North latitude and 74^0 40' to 78^0 15' East longitude having 300 to 900 meter height over the mean sea level and comes under the deccanplateau region of southern India. The mean annual rainfall ranges from 510 to 1131 mm comprising scarcity zone under Beed and Osmanabad district to that of assured rainfall region of Nanded, Parbhani and part of Hingoli district. Osmanabad district is located between 18^0 28' to19^0 28' North altitude and 76^0 25' to 77^0 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 43.3^0C and 11.9^0C, 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 tahsils, out of these Tuljapur Tehsil is considered for the study.
Total area of Tuljapur Tehsil is 143400 ha out of which cultivated area are 123324 ha, in which heavy soils are 44337 ha, light soils are 78927 ha, and pasture land is 20076 ha. Area under red soil, black soil, sandy loam soil and sandy soil is 111019, 16270, 15274 and 190 ha, respectively. The average rainfall of Tuljapur Tehsil is 743mm. Main crops grown in Tuljapur Tehsil during *kharif* season are sorghum, maize, pearl millet (cereals), pigeon pea, black gram (pulses), soyabean, groundnut, sunflower (oilseeds) and sugarcane (cash crop).
The chemical characteristics like, pH, EC, organic carbon and calcium carbonate are important as these effect 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 percent and its percent 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 percent total nitrogen is present in the organic form and only about 2 percent in inorganic form. The inorganic form is liable to be lost through different types of losses like run off, ammonia volatization, 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 percent of the N exists as N_2 in the atmosphere and is not available to >99 percent 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 N_2molecules 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 N_2 molecules to the atmosphere (Singh and Singh, 2009) [18].

Global N fertilizer production will increase 60-90 percent by the year 2025 and two thirds of the total will be applied in the developing world. Understanding N leaching from fertilized agriculture is important for several reasons. Nitrogen is a very important nutrient element in agriculture. Inorganic N occurs primarily as nitrate in arable soils. Nitrate is subject to various processes such as plant uptake, leaching from soils among others nitrate leaching is a global problem. Recently, there have been many studies made in India which point to the danger of nitrate leaching and subsequent pollution of ground waters. Due to increased agricultural activity which is necessary for enhanced food production and also due to industrial activity, there is an increasing evidence of nitrate pollution of ground waters. (Soniya *et al*., 2011) [17].

Organic N forms can be fractionated into amino acid, amino sugars, hydrolysable NH_4-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 NH_4, 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) [1].

The present study is undertaken on "Assessment of different nitrogen forms in Soil orders viz. Vertisols, Inceptisols and Entisols in Marathwada Region" with following objectives:

1. To estimate different nitrogen fractions from soils
2. To study soil physicochemical properties

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 180 28' to190 28' North altitude and 760 25' to 770 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 43.30C and 11.90C, 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 Tehsil 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 Tehsil of Osmanabad district were Kakramba, Khandala, Wadgaodev, Kilaj, Horti, Jalkot, Hangarga, Sindhagao, Lohgao, Sindhafal, Masala, Kati, Jalkotwadi, Wadgao, Suratgao, Pinpala, Devkurali, Dhotri, Eatkal, Nilegao, Gujnur, Khumbhari, Nanduri, Vasantvadi, Chivari, AndurTirthbuduruk, Aapsinga, Kamtha, Mardi for collection of soil samples.

Collection of soil samples

In order to study the fertility status of soils from Tuljapur Tehsil 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 Tehsil 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) [4] 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) [4]. Electrical conductivity: It was estimated from supernant solution of soil water suspension (1:2.5) by using conductivity bridge (Jackson, 1973) [4]. 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) [13]. Nitrogen fractions Available nitrogen: It was analysed by alkaline potassium permagnate method as suggested by Subbiah and Asija (1956) [20]. Total nitrogen: Total nitrogen from soil samples was estimated by micro kjeldhal method as described by Page et al. (1989) [11].

Total hydrolysable nitrogen: It was estimated by steam distillation method as suggested by Bremner (1965) [11]. Amino acid nitrogen: It was estimated by steam distillation method as described by Bremner (1965) [11]. Acid insoluble nitrogen: It was analysed by steam distillation method as described by Bremner (1965) [11]. Ammonical nitrogen: It was evaluated by steam distillation method as suggested by Bremner (1965) [11]. Nitrate nitrogen: It was evaluated by steam distillation method as suggested by Bremner (1965) [11].

Results and Discussion

In order to determine the nitrogen fractions of the soils from Tuljapur Tehsil 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. Soil samples from Tuljapur Tehsil of Osmanabad district were analyzed for its chemical properties and nitrogen fractions. The correlation between chemical properties and different fractions of nitrogen in soil were also worked out. The results obtained after analysis are presented and discussed under following head. Chemical properties in soils of Tuljapur Tehsil out of 180 soil samples, 62 samples were grouped under Vertisols, while, 84 and 34 soil samples were placed in Inceptisols and Entisols, respectively. The data on chemical properties of soils from Tuljapur Tehsil are presented orderwise categorization of soils (Table 1). Vertisols: out of 62 soil samples of Vertisols, 5 samples (8 %) were normal and 57 samples (92 %) were alkaline in pH. All samples (100%) in Vertisols showed normal range hence these soils were safe for crops. Out of 62 samples, 20 samples (32%) were low, 28 samples (45%) were medium and 14 samples (23%) were high in organic carbon. CaCO3 content in the soils ranged from 5.0 to 81.0 g kg-1 with an average 48.7 g kg-1. Out of 62 samples, 27 samples (45%) were non-calcareous and 35 samples (55%) were calcareous in nature. Inceptisols: The soil pH varied from 7.0 to 8.9 with an average value of 8.2. It is revealed from the data 10 per cent soils were found neutral in reaction and 90 per cent soils were alkaline in reaction. Data revealed that all the soil samples from inceptisols were safe in EC. Out of 84 samples from Inceptisols, 27 samples were (32%) low, 33 samples (39%) were medium and 24 samples (29%) were high in organic carbon content. Out of 84 soil samples, 31 samples were (37%) non-calcareous in nature, 27 samples (32%) were calcareous and remaining 26 samples (31%) were highly calcareous. Entisols These soils were varied in pH from 6.1 to 8.9 with a mean value of 8.0. Out of 34 soil samples, 5 samples (15%) were neutral and 29 samples (85%) were alkaline in reaction. All the soil samples in Entisols order were safe, as far EC categorization. Most of soils in Entisols were low to medium in organic carbon content. Out of 34 soil samples, 23 samples (68%) were non- calcareous and remaining 11 samples were (32%) calcareous in nature. Thus, the majority soil samples in Entisols showed non-calcareous in nature. The data revealed that 92, 90 and 85 per cent soil samples in Vertisols, Inseptisols and Entisols, respectively were alkaline in reaction. These values of pH indicated that most of the soils under study were alkaline in reaction. The alkaline reaction of soil is probably due to the presence of sufficient free lime content and basaltic alluvium parent material rich inalluminosilicates and alkaline earth from which these are derived. Similar findings were also reported by Mali and Raut (2001) [8] that most of the soils of Latur district were alkaline in nature under Vertisols, Inceptisols and Entisols. With regards to soil EC, 100 per cent soil samples showed safe EC for growing crops. The values of EC obtained in the investigation were found within desirable range as proposed by Richard and Cambell (1948).[15] When EC exceeds 4 dSm1, the present salts become harmful to the crop growth. However, EC values below 1.0 dSm-1 was considered as normal. Normal range of EC of soil of Chakur and Shirur- anantpaltahsil were ranged from 0.13 to 0.79 and 0.12 to 0.75 dSm-1, respectively reported by Jagtap (2007).[5] It was observed that in Vertisol 32, 45 and 23 per cent soil samples were low, medium and high in organic carbon content, respecrively. While, in case of Inceptisols 32, 39 and 29 per cent soil samples were low, medium and high respectively. With regards to Entisol 44, 29 and 27 soil samples were low, mdium and high in organic carbon content, respectively. From the values of organic carbon, it was clearly depicted that the majority of soil samples were low to medium in range. The agro climate and agro ecological unit is very important from standpoint of soil fertility and plant growth. The content of organic carbon in soils depends on the range of precipitation within experimental area, considerable variation in precipitation is observed. The differences in the level of organic carbon in these soils are largely attributed to the pattern of rainfall in the area. In addition, hot and dry climate is directly related with the temperature variation in the region/ecological unit. Organic carbon is also attributed to the variation in decomposition rate. Similar results are also reported by Malewar et al. (2004) [9]. Majority soils from Vertisols and Inceptisols were calcareous in nature and contribute 56 and 37 per cent while, 68 per cent soils from Entisols were non-calcareous. Relative more accumulation of CaCO3 in Vertisols and associated black soils may be partly associated with their recent origin with rich in alkali earth and partly due to calcification process prevalent in this region (Joshi, 2000). Dhage et al. (2000) [3] reported that the CaCO3 content in Shevgaontahsil (A. nagar district) was ranged from 11.4 to 161.3 g kg-1. Similar range of CaCO3 (13.0 to 156 g kg-1) was recorded in swell- shrink soils of Vidarbha region (Padole and Mahajan, 2003) [12]. Similarly, Waghmare et al. (2007) reported that the CaCO3 content in Ausatahsil of Latur district was ranged from 8.80 to 125 g kg-1.Status of nitrogen fractions in soils of Tuljapur Tehsil the data on total N, available N, total hydrolysable N, amino acid N, acid insoluble N, ammonical N and nitrate N are presented under Vertisols, Inceptisols and Entisols, respectively. It is seen from the data (Table 2) total N content in Vertisols varied widely from 0.039 to 0.100 per cent with a mean value of 0.069 per cent. In Inceptisols, total N content ranged from 0.025 to 0.089 per cent with an average of 0.058 per cent. However, the total N content in Entisols varied from 0.021 to 0.081 with a mean value of 0.059. Relatively higher total nitrogen content in Vertisols is due to high clay content and lower values of total nitrogen in Inceptisols and Entisols may be associated with different parent material and it's rate of disintegration (Sharma and Mishra 1988) similar results also reported by Kumar et al., (1995) that the total N contents in the soils varied from 0.07 to 0.11 and 0.06 to 0.15 per cent in the surface and subsurface soils, respectively. From the results, it was observed that the available nitrogen content ranged from 106.60 to 404.50 kg ha^{-1} with an average of 189.01 kg ha^{-1} in Vertisols. In Inceptisols, available N varied from 90.90 to 373.20 kg ha^{-1} with a mean value 192.11 kg ha^{-1}. However, the available N content in Entisols varied from

100.40 to 276.00 kg ha^{-1} with an average value 184.57 kg ha^{-1}. The lower content of available nitrogen in this area was associated with hot and dry climate. Low content of organic matter and low total nitrogen reserve and in term C: N ratio of immobilized forms of nitrogen was reported by Malewar (1995) [9]. Similar results also reported by Waghmare and Takankhar (2007) [22] that in soil of Ausa and Nilanga Tahsil of Latur district available N content ranged from 102.2 to 385.7 kg ha^{-1} and 100.3 to 366.9 kg ha^{-1}, respectively. The mean values for total hydrolysable, amino acid, acid insoluble, ammonical and nitrate nitrogen in all the surface soil samples of Vertisols were recorded 531.18, 244.61, 167.65, 25.16 and 10.48 mg kg^{-1}, respectively. In Inceptisols, the mean values of total hydrolysable, amino acid, acid insoluble, ammonical and nitrate nitrogen recorded were 441.56, 203.09, 141.64, 20.87 and 8.69 mg kg^{-1}, respectively. However, in Entisols the mean values for total hydrolysable, amino acid, acid insoluble, ammonical and nitrate nitrogen recorded were 454.10, 207.57, 140.48, 21.28 and 8.86 mg kg^{-1}. Vertisols showed higher mean values for total hydrolysable, amino acid, acid insoluble, ammonical and nitrate nitrogen as compared to Inceptisols and Entisols which is partly attributed to higher content of total nitrogen in these soils as compared to other soil groups. Further, higher values of various fractions of nitrogen in Vertisols and Inceptisols may be associated with finer texture of soil and high organic carbon content. These findings are in accordance with the results of Singh and Singh (2007) [18] and Soniya et al. (2011).

Status of N fractions in Vertisols

The result (Table 2) was showed 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. Total hydrolysable nitrogen 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 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 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 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 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: Order wise categorization of soils from Tuljapur Tehsil on the basis of chemical properties

Para-meter		Soil orders								
		Vertisols			Inceptisols			Entisols		
		Acidic (< 6.5)	Neutral (6.5-7.5)	Alkaline (> 7.5)	Acidic (< 6.5)	Neutral (6.5-7.5)	Alkaline (> 7.5)	Acidic (< 6.5)	Neutral (6.5-7.5)	Alkaline (> 7.5)
pH	%	0	8	92	0	10	90	0	15	85
	No. Samples	0	5	57	0	8	76	0	5	29
EC (dSm^{-1})		Safe (< 0.8)	M. safe (0.8-2.5)	Unsafe (>2.5)	Safe (< 0.8)	M. safe (0.8-2.5)	Unsafe (>2.5)	Safe (< 0.8)	M. safe (0.8-2.5)	Unsafe (>2.5)
	%	100	0	0	100	0	0	100	0	0
	No. Samples	62	0	0	84	0	0	34	0	0
Organic carbon (g kg^{-1})		Low (< 5)	Medium (5- 10)	High (> 10)	Low (< 5)	Medium (5- 10)	High (> 10)	Low (< 5)	Medium (5- 10)	High (> 10)
	%	32	45	23	32	39	29	44	29	27
	No. Samples	20	28	14	27	33	24	15	10	9
$CaCO_3$ (g kg^{-1})		N.ca (<50)	Ca. (50-100)	H.ca (>100)	N.ca (<50)	Ca. (50-100)	H.ca (>100)	N.ca (<50)	Ca. (50-100)	H.ca (>100)
	%	45	55	0	37	32	31	68	32	0
	No. Samples	27	35	0	31	27	26	23	11	0

N.ca- Non calcareous, Ca. - Calcareous, H.ca-Highly calcareous, M. safe- Marginal safe

Table 2: Status of nitrogen fractions in Vertisols

S. 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 (mgkg^{1})
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
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

Inceptisols

The results (Table 3) showed that total nitrogen 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. 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.

Among the different nitrogen fractions, Total hydrolysable nitrogen 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 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 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.

Ammonical nitrogen 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 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.

Table 3: Status of nitrogen fractions in Inceptisols

S. 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 (mgkg^{1})
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
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
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

Table 4: Status of nitrogen fractions in Entisols

S. 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 (mgkg^{1})
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

Entisols

The data (Table) indicated that among the different nitrogen fractions, total nitrogen Maximum value was observed in soils (No. 48) from the village Sindafal and minimum in soils (No.86) collected from Suratgao village. Available N in these soil slowest 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 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 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 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 highest value was observed in soils (No. 48) collected from Sindafal village and

the lowest value observed in soils (No. 86) collected from Suratgao village. Nitrate nitrogen highest value was observed in soils (No. 48) collected from Sindafal village and it was the lowest in soils (No. 86) collected from Suratgao village in Entisols

Table 5: Range and average value of nitrogen fractions in soil

Soil order	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 (mgkg^{1})
Vertisols	0.039-0.100 (0.069)	106.60-404.50 (189.01)	292.00-750.00 (531.18)	136.50-350.00 (244.61)	90.00-250.00 (167.65)	14.04-36.00 (25.16)	5.85- 15.00 (10.48)
Inceptisols	0.025-0.089 (0.058)	90.90-373.20 (192.11)	190.00-672.00 (441.56)	87.50-311.50 (203.09)	60.00-228.50 (141.640	9.00-32.04 (20.87)	3.75- 13.35 (8.69)
Entisols	0.021- 0.081 (0.059)	100.40-276.00 (184.57)	157.50-633.36 (454.10)	73.50-284.20 (207.57)	52.50-199.50 (140.48)	7.56-29.16 (21.28)	3.15- 12.15 (8.86)

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