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ORIGINAL ARTICLE **OPEN ACCESS**

Effect of Integrated Nutrient Management practices on Distribution of different nitrogen fractions (mg kg^{-1}) by maize crop in Sigehadlu micro watershed of Chikkamagaluru district

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ABSTRACT
A field experiment was conducted at Sigehadlu micro watershed in the farmer's field during Kharif 2017, to effect of INM practices on distribution of different nitrogen fractions (mg kg^{-1}) in by maize crop in Sigehadlu micro watershed. Sigehadlu micro watershed under the Bilvala sub watershed Kadur taluk, Chikkamangluru district. There were two levels of nitrogen applied through organics (farmyard manure, vermicompost) and in-organics urea involving nine treatments combinations were tried in a RCBD with three replications. The results of the present investigation indicated that exchangeable NH_4^+-N and NO_3-N fraction (27.74, 20.13 and 11.66 mg kg^{-1}) at 30, 60 and harvest of the maize respectively. Considerable build up in all the organic N fractions viz., hydrolysable NH_4^+N, Amino acid-N, Hexosamine-N, unidentified hydrolysable-N could be observed in integrated treatment while the lowest concentrations of these fractions were observed in the plots which received only fertilizers without any organic manures.
Keywords: Amino acid-N, Hexosamine-N, unidentified hydrolysable-N, INM

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INTRODUCTION

Nitrogen occupies the unique position among the elements essential for crop growth and plays a fundamental role in various metabolic processes. In plants it is a major component of many important molecules including proteins, nucleic acids, certain hormones and chlorophyll. It was estimated that over 85 per cent of the total N is present in bound form and the major fractions are amino acid-N, hydrolysable and amino sugar-N [1]. Only a smaller portion of the total N was in the inorganic forms which constitute exchangeable NH_4^+-N, NO_3^--N and NO_2^--N [2]. Since a major portion of the soil total N is in organic form, the remaining inorganic forms of N present as NH_4^+-N is the precursor for all other remaining inorganic forms of N in both aerobic and anaerobic conditions. These inorganic forms may be lost from the soil through volatilization, leaching, runoff and are unavailable to the plants by fixation and immobilization. Hence, knowledge of relationship between soil nitrogen type, soil conditions and various physical and chemical properties with different nitrogen pools, their distribution and availability in soils may prove to be the best approach for obtaining reliable information about the soil nitrogen [3].

Most soils in India are deficient in organic matter and nitrogen and hence application of nitrogen is necessary for increasing the yield of crops. With the advent of modern high yielding varieties, emphasis has been mainly on the use of chemical fertilizers neglecting the organic manures resulting in the deficiency of several macro and micronutrients. The current world energy crisis and consequent price hike of fertilizers due to withdrawal of subsidy on fertilizers coupled with the low purchasing power of the farming community warrant the search for alternate nutrient sources. Hence, proper blending of organic manures with chemical fertilizers will improve soil health and help to maximize sustainable agricultural production. This is thus, linked to the concept of integrated nutrient management.

MATERIAL AND METHODS

A field experiment was conducted at Sigehadlu micro watershed in the farmer's field during *Kharif 2017*, to effect of INM practices on distribution of different nitrogen fractions (mg kg^{-1}) in by maize crop in Sigehadlu micro watershed. Sigehadlu micro watershed under the Bilvala sub watershed Kadur taluk, Chikkamangluru district, experimental site situated at 13.36° 49.978" North latitude, 76.00° 11.290" East longitude, at an altitude of 702 meters above mean sea level. The average rainfall of the zone is 600 mm. The experiment consisting of the 9 treatment with the three replications. Details of initial soil properties are presented in Table 1. Randomized Block design (RCBD) was followed. Maize was used (*Zea mays L.*) as a test crop variety CP 818, The details of the treatments are follows plot size was 5.4 m ×3.6 m and net plot size was 3.6 m ×2.4 m, the fertilizer recommendation is 150:75:40 $N:P_2O_5:K_2O$ kg ha^{-1}.

Treatment details:

T_1-Absolute control
T_2-100 % recommended N through a fertilizer
T_3-125 % recommended N through fertilizer
T_4-150 % recommended N through fertilizer
T_5-50 % N through fertilizer + 25 % N through FYM + 25 % N through Vermicompost
T_6-75 %N through fertilizer + 25 % N through FYM + 25 % N through Vermicompost
T_7-100 % N through fertilizer + 25 % N through FYM+25% N through Vermicompost
T_8-50 % N through fertilizer +50 % N through FYM
T_9-50 % N through fertilizer + 50 % N through Vermicompost

(Note: Recommended P and K applied are common to all treatments except absolute control)

RESULTS AND DISCUSSION

Distribution of nitrogen fractions in soil at 30, 60 and harvest of maize

Inorganic N fractions

The results of the present investigation indicated that exchangeable NH_4^+-N fraction in soil was significantly higher (27.74, 20.13 and 11.66 mg kg^{-1}) in treatment T_7 (100 % N applied through fertilizer+ 25 % applied through FYM + 25 % applied through vermicompost) and lowest was recorded in T_2 treatment (17.10, 12.19 and 7.95 mg kg^{-1}) at 30, 60 and harvest stage of maize respectively. Further, integrated treatments recorded higher amounts of exchangeable NH_4^+N as compared to that of the treatments which received only fertilizers. This could be attributed due to the increased rate of mineralization of organic matter in the soil which was enhanced by the addition of organic manures (FYM or vermicompost) and hence caused a buildup of NH_4^+N in soil. Similarly, Yadav and Singh (1991) reported that increasing rates of NPK application had a favorable influence on exchangeable NH_4^+N in soil. In the treatments where nitrogen applied only through fertilizers, exchangeable NH_4^+N contents were low probably because of leaching loss [4]. A positive effect of 100 per cent and 125 percent N substitution through FYM or vermicompost was observed in terms of improved NH_4-N contents of the soil due slow release and retention by soil. This is tune with the observations made by Santhy *et al.* [7].

In this study NO_3-N recorded significantly higher in the treatment (T_7) which received 100 % N applied through fertilizer+ 25% applied through FYM + 25 % applied through vermicompost, which recorded NO_3-N of (21.73, 17.18 and 7.46 mg kg^{-1}) at 30, 60 and at harvest stage of maize respectively, and lowest was recorded in T_2 treatment (13.23, 7.13 and 5.12 mg kg^{-1}) at 30, 60 and harvest stage of maize respectively. Further, integrated treatments T_6, T_7, T_8 and T_9 with combined application of organics and fertilizers recorded higher NO_3-N as compared to other treatments which received nitrogen only fertilizers without any organics. The NO_3-N content in the soil at any given time depends upon the rate of formation, crop removal, leaching, volatilization, denitrification, addition of NO_3-N through fertilizers and organic manures and rate of mineralization [6]. This could be attributed to increased microbial activity increase in soil pH might have enhanced nitrification process with a reduction in leaching losses [1].

Organic N fractions

Considerable build up in all the organic N fractions viz., hydrolysable NH_4^+N, Amino acid-N, Hexosamine-N, unidentified hydrolysable-N could be observed in integrated treatment while the lowest concentrations of these fractions were observed in the plots which received only fertilizers without any organic manures. Various organic N fractions in soil indicated an appreciable increase in their contents due to the treatment T_7 (100% N applied through fertilizer + 25 % applied through FYM + 25 % applied through vermicompost) and graded levels of fertilizers along with FYM and vermicompost integrated treatment. Among the organic N- fraction, amino acid-N was the most dominant fraction followed by hydrolysable NH_4-N and hexosamine -N. This indicates that total hydrolysable -N contributed more to the total -N compared to other fractions, thus indicating the existence of major portion of N in the organic form [9].

Table 1. Physical and chemical properties of the experimental site

Properties	Values
Soil taxonomy	*Typic haplustalf*
Sand (%)	60.75
Silt (%)	11.75
Clay (%)	27.50
Textural class	Sandy Clay Loam
pH	6.77
Electrical conductivity (dS m^{-1})	0.12
Organic carbon (g kg^{-1})	4.10
Available Nitrogen (kg ha^{-1})	184.45
Available Phosphorus (P_2O_5 kg ha^{-1})	35.48
Available Potassium (K_2O kg ha^{-1})	196.35
Nitrogen fractions (mg kg^{-1})	
Total Nitrogen	316
Exch NH_4^+-N	13.25
NO_3-N	9.12
HAN	74.25
HSN	19.67
AAN	87
UHN	34
THN	269
NHN	24.38

Table 2: Effect of integrated nutrient management practices on distribution of different nitrogen fractions (mg kg^{-1}) in soil at 30 days after sowing of maize

Treatments	NO_3-N	Exch.NH_4^+-N	Hydrolysable nitrogen					NHN	Total Nitrogen
			HAN	HSN	AAN	UHN	THN		
T_1:Absolute Control	11.08 (2.96)	15.08 (4.03)	82.42 (22.01)	25.16 (6.70)	112.00 (29.91)	64.00 (17.09)	315.33	33.09 (8.84)	374.51
T_2:100% Recommended N through a fertilizer	13.23 (3.44)	17.10 (4.45)	97.11 (25.25)	28.10 (7.30)	122.67 (31.89)	78.00 (18.46)	316.89	37.33 (9.70)	394.67
T_3:125% Recommended N through fertilizer	14.09 (3.52)	19.52 (4.87)	102.08 (25.48)	30.23 (7.54)	130.67 (32.61)	81.00 (20.22)	323.00	38.19 (9.53)	400.67
T_4:150% Recommended N through fertilizer	14.63 (3.57)	19.85 (5.09)	104.23 (25.44)	33.08 (8.07)	134.67 (32.87)	82.33 (20.09)	333.67	40.14 (9.80)	409.74
T_5:50 % N through fertilizer +25% N through FYM+25% N through vermicompost	20.10 (3.81)	22.08 (5.22)	111.16 (26.06)	40.76 (9.64)	156.33 (34.36)	89.67 (19.78)	342.00	43.12 (10.19)	423.00
T_6:75% N through fertilizer + 25% N through FYM+25% N through vermicompost	20.19 (4.45)	26.09 (5.53)	113.10 (24.95)	42.17 (9.30)	155.00 (33.75)	90.42 (20.00)	354.00	57.13 (12.60)	468.33
T_7:100% N through fertilizer+ 25% N through FYM+25% N through vermicompost	21.73 (4.60)	27.13 (5.75)	119.10 (25.23)	46.09 (9.76)	159.33 (33.76)	92.31 (19.63)	361.00	62.17 (13.17)	472.00
T_8:50% N through fertilizer +50 % N through FYM	18.76 (4.74)	22.23 (5.08)	109.79 (25.09)	40.89 (9.34)	151.67 (33.76)	89.00 (20.33)	341.00	53.08 (12.13)	437.67
T_9:50% N through fertilizer + 50 % N through vermicompost	17.38 (4.86)	21.89 (4.97)	110.79 (25.22)	41.00 (9.32)	149.67 (34.65)	88.14 (20.15)	343.00	54.09 (12.29)	440.12
SEm ±	1.28	0.60	2.75	1.57	1.82	2.07	2.89	2.44	3.13
CD at 5%	3.83	1.81	8.25	4.71	5.46	6.22	8.67	7.32	9.37

Note: 100% P & K is common applied to all treatments except absolute control
DAS-Days after sowing
Figures in parenthesis indicate percentage distribution of nitrogen fractions.
Exch NH_4^+-N Exchangeable ammonical nitrogen, $N0_3^-$-N Nitrate nitrogen, HAN-Hydrolysable ammonical nitrogen, AAN-Amino acid nitrogen, UHN-Unidentified hydrolysable nitrogen THN-Total hydrolysable nitrogen, HSN: Hexosamine nitrogen, NHN-Non hydrolyable nitrogen, Total N-Total nitrogen

The application of NPK along with either FYM or vermicompost favored immobilization of N in different hydrolysable fractions and also improved the level of organic nitrogen. The accumulation of slightly higher amounts of N as hydrolysable and non-hydrolysable in integrated nutrient management

treatments was observed. This could be due to higher biomass production and predominance of cereal crops which will return lot of roots and stubbles to the soil [8]. Similarly, Duraiswamy, [5] reported that increased amounts of organic N fractions under FYM and vermicompost plus fertilizers treatments would indicate that the added forms of inorganic and organic N undergo series of transformation processes and thereby contributing to each pool of organic N formed in soil . A study conducted by Subba Rao and Ghosh [8] revealed that there existed a equilibrium between immobilization and mineralization processes going on individual fractions with a clear and perceptible shift towards greater immobilization and consequent accumulation of nitrogen in organic forms.

Table 3: Effect of integrated nutrient management practices on distribution of different nitrogen fractions (mg kg^{-1}) in soil at 60 days after sowing of maize

Treatments	NO_3-N	Exch.NH_4^+-N	Hydrolysable nitrogen					NHN	Total Nitrogen
			HAN	HSN	AAN	UHN	THN		
T_1:Absolute Control	6.03 (1.79)	9.73 (2.90)	72.19 (21.49)	19.42 (5.78)	106.00 (31.55)	58.00 (17.26)	291.97	28.24 (8.41)	335.97
T_2:100% Recommended N through a fertilizer	7.13 (2.07)	12.19 (3.53)	88.09 (25.52)	21.04 (6.10)	120.00 (34.77)	62.00 (17.96)	296.00	30.12 (8.73)	345.13
T_3:125% Recommended N through fertilizer	9.10 (2.58)	10.92 (2.93)	93.12 (26.45)	21.29 (6.05)	122.09 (34.68)	70.00 (19.88)	300.58	32.09 (9.11)	352.08
T_4:150% Recommended N through fertilizer	9.26 (2.57)	11.08 (3.08)	94.08 (26.11)	21.64 (6.01)	123.10 (34.17)	72.16 (20.01)	302.63	37.30 (10.35)	360.27
T_5:50 % N through fertilizer +25% N through FYM+25% N through vermicompost	14.09 (2.94)	18.09 (3.73)	102.08 (27.02)	24.09 (6.38)	130.20 (34.46)	76.10 (19.61)	313.67	39.00 (10.32)	413.84
T_6:75% N through fertilizer + 25% N through FYM+25% N through vermicompost	15.24 (3.50)	19.09 (4.49)	104.04 (25.83)	28.09 (6.97)	135.00 (33.52)	77.13 (19.15)	326.97	50.19 (12.46)	418.78
T_7:100% N through fertilizer+ 25% N through FYM+25% N through vermicompost	17.18 (4.02)	20.13 (4.74)	106.12 (24.98)	30.23 (7.12)	142.00 (33.43)	80.12 (18.86)	330.42	57.13 (13.45)	424.01
T_8:50% N through fertilizer +50 % N through FYM	15.12 (3.75)	18.87 (3.75)	97.13 (24.11)	22.08 (5.48)	132.00 (32.76)	76.98 (18.42)	324.67	48.08 (11.93)	412.45
T_9:50% N through fertilizer + 50 % N through vermicompost	16.15 (3.94)	18.41 (4.02)	97.24 (23.83)	22.26 (5.46)	130.29 (31.93)	76.94 (18.40)	324.67	49.56 (12.15)	408.73
SEm ±	0.72	0.38	2.31	1.63	1.39	1.99	2.96	2.56	2.91
CD at 5%	2.16	1.14	6.93	4.89	4.17	5.97	8.88	7.68	8.73

Note: 100% P & K is common applied to all treatments except absolute control DAS-Days after sowing
Figures in parenthesis indicate percentage distribution of nitrogen fractions.
Exch NH_4^+-N Exchangeable ammonical nitrogen, $N0_3^-$-N Nitrate nitrogen, HAN-Hydrolysable ammonical nitrogen, AAN-Amino acid nitrogen, UHN-Unidentified hydrolysable nitrogen THN-Total hydrolysable nitrogen,HSN:Hexosamin nitrogen, NHN-Non hydrolyable nitrogen, Total N-Total nitrogen

Table 4: Effect of integrated nutrient management practices on distribution of different nitrogen fractions (mg kg^{-1}) in soil at harvest stage of maize

Treatments	NO_3-N	Exch.NH_4^+-N	Hydrolysable nitrogen					NHN	Total Nitrogen
			HAN	HSN	AAN	UHN	THN		
T_1:Absolute Control	3.34 (1.06)	6.74 (2.15)	68.67 (21.89)	15.00 (4.78)	99.00 (31.56)	44.00 (15.94)	273.33	18.26 (7.42)	313.67
T_2:100% Recommended N through a fertilizer	5.12 (1.58)	7.95 (2.46)	81.67 (25.23)	17.20 (5.31)	112.00(34.91)	53.00 (16.37)	284.00	26.60 (8.22)	323.67
T_3:125% Recommended N through fertilizer	5.26 (1.61)	7.99 (2.44)	89.00 (27.22)	18.19 (5.56)	112.20 (34.62)	59.00 (18.04)	287.00	28.75 (8.79)	327.00
T_4:150% Recommended N through fertilizer	6.04 (1.76)	8.75 (2.55)	89.04 (25.96)	18.1 (5.29)	114.67 (33.14)	59.32 (17.29)	294.00	34.76 (10.13)	335.00
T_5:50 % N through fertilizer +25% N through FYM+25% N through vermicompost	7.05 (1.97)	10.19 (2.85)	92.08 (25.74)	20.55 (5.75)	126.00 (33.55)	64.08 (17.92)	305.00	35.00 (9.79)	357.67
T_6:75% N through fertilizer + 25% N through FYM+25% N through vermicompost	7.46 (2.05)	11.08 (3.04)	91.75 (25.18)	21.00 (5.76)	128.00 (34.86)	64.19 (17.62)	314.67	40.33 (11.07)	364.33

T_7:100% N through fertilizer+ 25% N through FYM+25% N through vermicompost	7.76 (2.07)	11.66 (3.10)	92.86 (24.72)	23.06 (6.14)	129.00 (34.34)	66.30 (17.65)	313.00	43.09 (11.47)	375.67
T_8:50% N through fertilizer +50 % N through FYM	7.26 (1.97)	11.00 (2.98)	89.75 (24.34)	20.72 (5.62)	124.00 (32.28)	65.12 (16.31)	310.00	40.42 (10.96)	368.67
T_9:50% N through fertilizer + 50 % N through vermicompost	7.32 (1.96)	11.05 (2.96)	89.99 (24.08)	20.62 (5.52)	129.36 (32.11)	65.08 (16.61)	306.33	40.37 (10.80)	373.67
SEm ±	0.32	0.26	1	1.39	1.54	1.26	2.94	2.23	2.23
CD at 5%	0.96	0.79	4.17	0.93	4.62	3.78	8.82	6.69	6.69

Note: 100% P & K applied to all treatments except absolute control. DAS-Days after sowing
Figures in parenthesis indicate percentage distribution of nitrogen fractions.
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