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ASSESSMENT OF AVAILABLE NITROGEN, INORGANIC NITROGEN FRACTIONS AND ENZYME ACTIVITY IN SOILS UNDER PREDOMINANT CROPPING SYSTEMS OF NORTHERN TELANGANA ZONE

K. Madhulatha*, G. Venugopal and R. Sai Kumar
Department of Soil Science and Agricultural Chemistry, Agricultural College, (Professor Jayashankar Telangana Agricultural University) Jagtial-505327 Telangana, India.
*Corresponding author Email: kmadhulatha786@gmail.com
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ABSTRACT

The study was conducted during *rabi* season, 2023-24 at different locations of farmer's fields of Northern Telangana Zone. The main aim of the study was to assess the available nitrogen, inorganic nitrogen fractions and enzyme activity in soils of Northern Telangana Zone. A total of 75 samples were collected from the predominant cropping systems of NTZ *viz*., cotton-bengal gram (CS_1), soybean-bengal gram (CS_2), turmeric-sesame (CS_3), paddy-paddy (CS_4) and paddy-maize (CS_5) at different depths (0-15, 15-30 and 30-45 cm). The available nitrogen, soil inorganic nitrogen fractions *viz*. NH_4-N, NO_3-N, TN and enzyme activity were significantly varied among different cropping systems with soil depths. Among the cropping systems, the available N, NH_4-N, NO_3-N and TN were significantly, higher in soybean-bengal gram (CS_2) (228.1 kg ha^{-1}, 101, 57.4, and 1482 mg kg^{-1}, respectively) which was on par with turmeric-sesame (CS_3) (213.8 kg ha^{-1}, 95.0, 53.8 and 1413 mg kg^{-1}, respectively) followed by paddy-paddy (CS_4) (205 kg ha^{-1}, 91.2, 51.7 and 1369 mg kg^{-1}, respectively), whereas NH_4-N, NO_3-N and TN were lower in cotton-bengal gram (CS_1) (197 kg ha^{-1}, 87.7, 49.7 and 1253 mg kg^{-1}, respectively) and paddy-maize (CS_5) (184 kg ha^{-1}, 81.8, 46.4 and 1232 mg kg^{-1}, respectively) in soil. Soil samples were analyzed for soil enzyme activity like dehydrogenase and urease activity. The highest enzyme activity (dehydrogenase & urease) was observed under turmeric-sesame (CS_3) (16.8 µg TPF g^{-1} d^{-1} and 7.58 µg NH_4-N g^{-1} hr^{-1}, respectively), which was on par with soybean-bengal gram and lowest was found in paddy-maize (CS_5) (9.21 µg TPF g^{-1} d^{-1} and 3.79 µg NH_4-N g^{-1} hr^{-1}, respectively). The relation between urease activity and available nitrogen was significantly positively correlated.

Keywords **:** Cropping systems, depths, inorganic nitrogen fractions, enzymatic activity.

Introduction

India has been an agricultural society since, time immemorial (Abhilash *et al*., 2022) which, has been blessed to have a wide range of climatic conditions and ensures to grow a wide range of crops. In Northern Telangana Zone, paddy, maize, turmeric, soybean and cotton are predominant crops, which have been cultivating during the *kharif* season. Others like sesame and bengal gram are major *rabi* crops. Paddy, maize, cotton, turmeric and soybean are cultivating in an area of 20.5 lakh acres, 1.7 lakh acres, 12.5 lakh acres, 0.34 lakh areas and 3.8 lakh acres, respectively. Receiving annual rainfall ranges from 900 to 1150 mm mostly during southwest monsoon season. Minimum and maximum temperatures during winter and summer seasons range between 15°C to 25°C and 32°C to 40°C, respectively with 76-95 % humidity. Red soils are predominant soils in this zone, which include chalks, red sands and deep red loams along with very deep black cotton soils (Weather and Climatology of Telangana, Directorate of Economics and Statistics (DES) Planning Department, Government of Telangana, 2024). Due to several factors like excess or less usage of fertilizers, the addition of inorganic fertilizers without organics, intensive cultivation and

improper management practices lead to a decline in crop yields as well as deterioration of soil health.

Adopting a crop diversification system is a promising approach, as it is a sensible strategy for attaining the objectives of food security, employment, increased revenue and sustainable agricultural development (Anamika *et al*., 2022).

However, deterioration in the soil fertility under continuous cultivation of same cropping systems led to a reduction in the crop yields. Therefore, studying the effect of exhaustive cropping systems like paddy, maize and cotton on the availability of macronutrients is essential. This could aid in understanding the soil status. Furthermore, improving the productivity of the crops by managing the soil fertility.

Material and Methods

The study was carried out in Northern Telangana Zone covering districts of Adilabad, Nizamabad, Jagtial, Karimnagar and Peddapally. In Adilabad, Tamsi, Adilabad rural and Tallamadugu mandals were identified for cotton-bengal gram as the predominant cropping system and covering an area of 2,128 ha. In Nizamabad, Bodhan, Pothangal, Kotagiri, Morthad and Dammanapet mandals were identified for cotton-bengal cropping system covering an area of 4288 ha. In Jagtial, turmeric-sesame cropping system was considered as major cropping system in Kathlapur and Metpally mandals with an area of 2419 ha. In Peddapally and Karimnagar, paddy-paddy cropping system was considered as major cropping system in Peddapally Kamanpur, Gangadhara and Ramadugu mandals with an area of 22920 ha. In Karimnagar, paddy-maize cropping system was identified from Veleru, Bheemadevarpally, Chigurmamidi, Koheda and Ramchandrapuram with an area of 25120 ha.

All necessary precautions were taken while collecting the samples and GPS coordinates were noted. Samples were collected in a zig-zag pattern and 2 cm-thick slice of soil was removed from the top layer. These samples were combined to make a composite sample and extra soil was removed using the quartering method. Finally, half kg composite samples from each sampling field were obtained. After collection, soil samples were brought to the laboratory and allowed to air dry under shade. Stones, pebbles, roots, etc. were removed and the soils were pounded in a wooden mortar and pestle and sieved through a 2 mm sieve. The samples were stored in air-tight plastic boxes, labeled properly and the soil samples were analyzed to find inorganic nitrogen fractions and enzymatic status in the cropping systems.

Available Nitrogen (kg ha^{-1})

Five g of 2 mm sieve soil sample undergoes oxidative-hydrolysis by 30 mL of 0.32 % of $KMnO_4$ and 30 mL of 2.5 % NaOH was used to maintain alkaline conditions which were placed in 300 mL Kjeldhal tube. Following oxidation, the ammonia liberated is condensed, distilled and absorbed into 25 mL of 2.5 % boric acid with mixed indicator solution, which is then titrated against 0.01 N sulphuric acid until the color changes from light green to pink. Simultaneously a blank was run without soil (Subbiah and Asija, 1956).

Inorganic nitrogen fractions

Total nitrogen

Total N was analyzed by using 2 g of soil treated with salicylic acid and 20 mL of concentrated sulphuric acid in a 500 mL kjeldhal flask and stir the mixture for 30 minutes at room temperature. Afterwards, add 5 g of sodium thiosulfate and 20 g of digestion mixture and then digest the contents at 420^{o} C using a digester. Add 40 % NaOH solution in the distillation setup to capture the ammonia in a mixture of 4 % boric acid and an indicator solution. Add 0.01 N sulfuric acid to the solution gradually until the blue-green color transforms into pink. The amount of sulfuric acid used determines the titration necessary to calculate the total nitrogen content in the soil (Page *et al*., 1982).

Ammonical nitrogen

The soil sample was subjected to extraction and filtration using a solution of 2 M KCl. Subsequently, the filtrate underwent steam distillation in the presence of 0.2 g MgO and 2.5 % NaOH. The resulting distillate was gathered in a solution containing 4 % boric acid along with a mixed indicator and then titrated using standard sulfuric acid (0.02 N) (Bremner, 1965).

Nitrate nitrogen

A soil was subjected to a one-hour extraction process using a 2 M potassium chloride solution, followed by filtration. The nitrate nitrogen content (NO_3-N) was isolated through steam distillation of the filtrate in the presence of 2.5 % NaOH and 0.2 grams of Devarda's alloy. The resulting distillate was gathered in a 4 % boric acid solution containing a mixed indicator and subsequently titrated using standard 0.02 N sulfuric acid (Bremner,1965).

Enzyme activity

Dehydrogenase enzyme

Dehydrogenase activity was estimated by adding 6 g of soil sample to a sealed test tube with a screw

cap, along with 0.1 g of calcium carbonate, 1mL of tetrazolium chloride 3 % aqueous solution and 2.5 mL of distilled water. Combine the contents and let them sit at room temperature for 24 hours at 30°C in the absence of light. Take out the stopper and mix the contents with 10 mL of methanol for 1 minute and then the pink color will appear in the tube. Pass the suspension through a Whatman No. 42 filter paper with a glass funnel. Repeat the extraction with 10 mL of methanol if the soil still shows a pink color and quantify the intensity at 485 nm wavelength using a spectrophotometer with methanol as a reference. The outcomes showed the amount of triphenyl formazan (TPF) produced per gram of sample per day was measured in milligrams. (Cassida *et al*., 1964).

Urease enzyme

Soil samples were analyzed for urease activity using this method based on the amount of NH_4 that is liberated after the soil is incubated with urea solution for two hours at 30°C. Five g of soil was taken in duplicate and placed in a 50 mL volumetric flask. 0.2 mL of toluene and 9 mL of THAM buffer (pH: 9.0, 0.05 M) were added. The conical flasks were used to shake and mix the contents. 0.2 M urea solution was then added and swirled once again. The flasks were then kept in an incubator for two hours at 30°C. The reaction was stopped by adding 15 mL of KCl-$AgSO_4$ solution, once the stoppers had been removed after two hours, to release all the NH_4 that had been produced and allow the suspension to settle, the contents were agitated on a mechanical shaker for an hour. Pour 1 mL of the soil suspension supernatant into a 25 mL volumetric flask. Add 1 mL of 6 % EDTA solution, 2 mL of phenol nitroprusside and 8 mL of the buffered hypochlorite reagent. Mix the contents completely by repeatedly inverting the container, then set it on a water bath at 40°C. Give 30 minutes for color development. Take the flasks out of the water bath and let stand till warm. A spectrophotometer was used to measure the blue-colored complex's absorbance at 636 nm. Run a blank simultaneously by following the above procedure without a sample (Tabatabai and Bremner, 1972). The standard protocols were used. The ANOVA was calculated by using a two-factorial analysis.

Statistical analysis and interpretation of data

The data was analyzed using analysis of variance (ANOVA). Two-factor factorial ANOVA was used to determine the existence of an interaction effect between cropping systems and depths. A simple correlation coefficient was also developed to evaluate relationships between the response variables using the same statistical package. The 5 % probability level was regarded as statistically significant (Panse and Sukhatme, 1978).

Results and Discussion

Available N (kg N ha^{-1})

The available nitrogen was significantly influenced by the cropping systems and soil depths. The data pertaining to available N was represented in Table 1.1. With regards to the cropping systems, the highest available nitrogen was recorded under soybean-bengal gram cropping system (228.1 kg ha^{-1}) and was on par with CS_3 (213.8 kg ha^{-1}). An 11.2 % and 15.7 % reduction in the availability of available nitrogen was recorded under CS_4 and CS_1, respectively over CS_2 (228.1 kg ha^{-1}). Significantly the lowest available nitrogen was registered with CS_5 system (184 kg ha^{-1}).

The presence of organic debris from leaf fall, plant waste degradation, the utilization of the growth resources more effectively and the symbiotic nitrogen fixation capacity by legume crops has resulted in an increase in available nitrogen. Similar results were obtained with Tuti *et al*. (2013). The inclusion of pulses in the cropping system boosts the available nitrogen level in the soil and benefits the crop. These findings are further supported by Kumari *et al*. (2022) and Karthik *et al*. (2023).

Leguminous crops have the potential to obtain atmospheric nitrogen through symbiosis with a species of soil bacteria called *rhizobia*, which allows them to require minimum N fertilizer inputs. This could explain the marginal rise in crops or cropping systems that incorporate leguminous crops in the system. Similar outcomes have been revealed by Van and Hartley, (2000) and Knight *et al*. (2020).

The available N was decreased with increasing the soil depth. The highest available nitrogen was noted at 0-15 cm (242.8 kg N ha^{-1}) followed by at 15-30 cm (202.3 kg N ha^{-1}). The least available nitrogen was registered at 30-45 cm (172.1 kg N ha^{-1}).

In all the cropping systems under consideration, the available nitrogen decreased with depth. This could be because of the increased pH, which caused organic materials to degrade quickly and reflect a low level of available nitrogen. Comparable outcomes were noted by Dhage *et al*. (2000).

Inorganic nitrogen fractions

Organic nitrogen makes up around 92-98 % of the total nitrogen in the soil, which is a greater portion of the nitrogen in the soil. However, crops cannot take organic nitrogen directly. It must be transformed into

inorganic nitrogen Mao *et al*. (2018) and Cheng *et al*. (2024). The predominant inorganic forms of nitrogen in soils are ammonical-nitrogen (NH_4-N^+) and nitrate-nitrogen (NO_3-N^-). Cropping systems had a considerable impact on the concentrations of ammonical nitrogen, nitrate nitrogen and total nitrogen, which was discussed below.

Total nitrogen

Total nitrogen refers to the potential supply of available nitrogen for plant absorption. A higher total nitrogen level in the soil usually suggests a greater ability to sustain plant growth via the nitrogen cycle. Total nitrogen is the primary indicator of soil fertility and quality in agricultural ecosystems (Meng *et al*., 2022).

The data representing total nitrogen was presented in Table 1.1. With regards to cropping systems, the TN was recorded highest in CS_2 (1482 mg kg^{-1}) over other cropping systems, which was on par with CS_3 (1413 mg kg^{-1}). However, the lower TN was recorded under CS_5 (1232 mg kg^{-1}) which was on par with CS_1 (1253 mg kg^{-1}).

Including pulse crops in rotations can improve total nitrogen levels through residual input and root deposition. It is commonly known that after harvesting of legumes, they fixes a significant amount of nitrogen in the soil. Additionally, with higher amount of organic matter inclusion under pulse-based cropping systems, increased total N was observed. Similar results were reported by Yantai *et al*. (2015).

With increasing soil depth from surface (0-15 cm) to sub-surface (15 to 30 and 30 to 45 cm) the TN was significantly decreased, the highest was recorded at 0-15 cm (1843 mg kg^{-1}) followed by 15-30 cm (1342 mg kg^{-1}) and 30-45 cm (865 mg kg^{-1}), respectively. The interaction effect of the cropping system and soil depth was found to be non-significant.

Total N accumulated in top soil layers has gradually decreased with increasing soil depth. This might be due to the low addition of root biomass and organic matter at subsurface soil layers. The results coincided with the findings of Jiao *et al*. (2010) and Zhao *et al*. (2015).

Ammonical nitrogen (mg kg^{-1})

Ammonical nitrogen is a product of the decomposition of organic matter. Plants can easily absorb ammonical nitrogen and use it directly for growth.

The data representing ammonical nitrogen was presented in Table 1.1. With regards to cropping systems, the NH_4-N^+ was recorded higher in CS_2 (101 mg kg^{-1}) over other cropping systems, which was on par with CS_3 (95 mg kg^{-1}). However, the lower NH_4-N^+ was recorded under CS_5 (81.8 mg kg^{-1}) which was on par with CS_1 (87.7 mg kg^{-1}).

The higher NH_4-N^+ was observed in soybean-bengalgram cropping system. This might be due to the addition of easily decomposable organic matter. *viz*. leaf litter, root biomass as well as higher effective nodules which could fix the higher atmospheric nitrogen. Ultimately higher ammonification. Further nitrification process might have led to the buildup of higher NH_4-N^+ and NO_3-N^- in the pulse-based cropping system.

With increasing soil depth from surface (0-15 cm) to sub-surface (15 to 30 and 30 to 45 cm) the NH_4-N^+ was significantly decreased, the highest was recorded at 0-15 cm (108 mg kg^{-1}) followed by 15-30 cm (89.8 mg kg^{-1}) and 30-45 cm (76.6 mg kg^{-1}), respectively.

Low amount of organic matter and low amount of nitrifying bacteria might have led to the decreased ammonical nitrogen with the increasing soil depths. The results were coincided with Subhajit *et al*. (2011). The interaction effect of the cropping system and soil depth was found to be non-significant.

Nitrate nitrogen (mg kg^{-1})

Nitrate nitrogen is extremely mobile and quickly available for plant absorption. Plants may readily absorb nitrate ions from the soil, making them an essential nutrient for growth.

The data representing nitrate nitrogen was presented in Table 1.1. With regards to cropping systems, the NO_3-N^- was recorded highest in CS_2 (57.4 mg kg^{-1}) over other cropping systems, which was on par with CS_3 (53.8 mg kg^{-1}). However, the lowest NH_4-N^+ was recorded under CS_5 (46.4 mg kg^{-1}) which was on par with CS_1 (49.7 mg kg^{-1}).

Legumes in cropping systems showed significantly higher soil NH_4-N^+ and NO_3-N^- levels than other cropping systems. This was explained by the fixation of atmospheric N_2 by legume crops and the restoration of N in the soil. Similar results were obtained with Olemann *et al*. (2007). Whereas, in the cotton-bengalgram cropping system, extensive and deeply established crops might have exhausted the N, which led to low nitrate nitrogen. Comparable outcomes were attained with Vidyavathi *et al*. (2021).

With increasing soil depth from surface (0-15 cm) to sub-surface (15 to 30 and 30 to 45 cm) the NO_3-N^- was significantly decreased, the highest was recorded

at 0-15 cm (61.1 mg kg^{-1}) followed by 15-30 cm (50.9 mg kg^{-1}) and 30-45 cm (43.4 mg kg^{-1}), respectively.

The decrease in nitrifying bacterial population with depth could account for the decrease in nitrate-nitrogen concentration among soil depths. Analogous results were obtained with Subhajit *et al*. (2011). The interaction effect of the cropping system and soil depth was found to be non-significant.

Table 1.1 : Effect of cropping systems with depth-wise variations on soil inorganic nitrogen fractions in Northern Telangana Zone.

Factor-I Cropping system	NH_4-N^+ (mg kg^{-1})	NO_3-N^- (mg kg^{-1})	TN (mg kg^{-1})	Available N (kg ha^{-1})
CS_1	87.7	49.7	1253	197
CS_2	101	57.4	1482	228
CS_3	95.0	53.8	1413	213
CS_4	91.2	51.7	1369	205
CS_5	81.8	46.4	1232	184
Sem±	2.36	1.39	39.5	5.53
CD @ 5%	6.70	3.95	112	15.7
Factor-II Depths				
D_1 (0-15cm)	108	61.1	1843	242
D_2 (15-30cm)	89.8	50.9	1342	202
D_3 (30-45cm)	76.6	43.4	865	172
SEm±	1.83	1.08	30.6	4.28
CD @ 5%	5.19	3.06	86.7	12.1
Interaction (CS×D)				
SEm±	4.1	2.41	68.4	9.58
CD @ 5%=	NS	NS	NS	NS
CV	10.0	10.4	11.3	10.4

*CS_1-Cotton-bengalgram, CS_2-Soybean-bengalgram, CS_3- Turmeric-Sesame, CS_4-Paddy- Paddy, CS_5- Paddy-Maize.

Enzymatic Activity

The soil enzymes are sensitive indicators for soil health. These effectively works under ideal conditions. Enzymes responds well to the management practices. Therefore, little alteration in the soil can modify the microbial population and activity of enzymes. Upendra *et al*. (2022).

Application of organics and crop rotation of the crops have been increasing the enzyme activity. Dick, (1984), Mohammadi *et al*. (2011) and Bei *et al*. (2016).

Dehydrogenase activity (µg TPF produced g^{-1} soil d^{-1})

DHA levels in soil can reflect overall microbial activity. Dehydrogenase plays a crucial role in several oxidative reactions that dehydrate organic compounds. The dehydrogenase enzymatic activity in the soil can be enhanced by adding various crop debris. Sekaran *et al*. (2021).

The activity of dehydrogenase was presented in Table 1.2. There was a significant variation observed among various cropping systems and soil depths. However, the variation among the combinations of cropping systems and soil depths were found to be non-significant.

Among the cropping systems, the highest activity of dehydrogenase was observed under the turmeric-sesame cropping system (CS_3) (16.8 µg TPF produced g^{-1} soil d^{-1}) and was on par with soybean-bengal gram cropping system (CS_2) (16 µg TPF produced g^{-1} soil d^{-1}) followed by paddy-paddy cropping system (CS_4) (14.6 µg TPF produced g^{-1} soil d^{-1}). The lesser activity was found under paddy-maize cropping system CS_5 (9.21µg TPF produced g^{-1} soil d^{-1}).

Since dehydrogenase refers to a class of intracellular activity, that catalyzes the oxidation of soil organic matter, dehydrogenase activity is used as an indicator of microbial activity. Similar results were found by Sandeep *et al*. (2023).

The data showed that dehydrogenase was significantly higher in turmeric-sesame cropping system. It might be due to the incorporation of higher plant residues and FYM, which are the main sources of carbon. Microorganisms comes out of starvation and starts the decomposition of residues. Thus, there was an increase in dehydrogenase by the dehydrogenation

process. Under pulse-based cropping systems, significantly higher soil dehydrogenase activity was found due to the addition of organic residue through leaf litter and root exudates of the crops. Additionally, the soil bacteria receive carbon and energy from decomposing root nodules and root tissues, which might lead to microbial population growth and an increase in dehydrogenase activity. Similar results were obtained with Geethakumari and Shivashankar, (1991) and Ashutosh *et al*. (2012).

The amount of soluble organic carbon in the soil determines the amount of DHA. The higher levels of organic matter in the surface soil boost the activity of soil enzymes. This finding was consistent with the investigations of Nannipieri *et al*. (2012) and Debnath *et al*. (2015). The main causes of the elevated DHA in the surface soil might be ascribed to the increased availability of nutrients, soluble organic C and microbial activity stimulants.

With regards to soil depths, the higher activity of dehydrogenase was recorded at 0-15 cm (15.1 µg TPF produced g^{-1} soil d^{-1}) followed by at 15-30 cm (14.1 µg TPF produced g^{-1} soil d^{-1}). The lower activity was observed at 30-45 cm (10.4 µg TPF produced g^{-1} soil d^{-1}).

As several microbiological qualities, such as DHA are higher in the surface layer and decreased significantly with increased soil depth, the decline in enzyme activity with soil depth appears to be caused by the decrease in oxidizable SOC fractions. Similar results were found by Melero *et al*. (2008) and Ashura *et al*. (2023).

Table 1.2 : Effect of cropping systems with depth-wise variations on soil dehydrogenase enzyme activity (µg TPF produced g^{-1} soil d^{-1}) in Northern Telangana Zone.

Cropping system	**0-15 cm**	**15-30 cm**	**30-45 cm**	**Mean (CS)**
CS_1	11.1	9.94	7.28	9.44
CS_2	18.5	17.6	11.7	16.0
CS_3	19.1	18.1	13.2	16.8
CS_4	16.5	15.5	11.9	14.6
CS_5	10.3	9.31	7.98	9.21
Mean (Depth)	15.1	14.1	10.4	
	S.Em±	**CD (5%)**	**CV (%)**	
CS	0.44	1.24	12.8	
depth	0.34	0.96		
CS X depth	0.76	NS		

*CS_1-Cotton-bengalgram, CS_2-Soybean-bengalgram, CS_3- Turmeric-Sesame, CS_4-Paddy- Paddy, CS_5- Paddy-Maize.

Urease activity (mg NH_4^+ released g^{-1} soil hr^{-1})

In the N cycle, the urease enzyme breaks down urea and produce readily available nitrogen for plant development. Sinsabaugh and Follstad, (2012) and Jince *et al*. (2023). Urease is crucial for utilizing urea fertilizer effectively in soil. Changes in urease activity can indicate variations in the available N pool in the soil. Velmourougane *et al*. (2013).

Data related to urease activity was presented in Table. 1.3. The CS_3 system recorded the highest urease activity (7.58 mg NH_4^+ released g^{-1} soil hr^{-1}) and was comparable to CS_2 (7.33 mg NH_4^+ released g^{-1} soil hr^{-1}). The CS_4 (6.44 mg NH_4^+ released g^{-1} soil hr^{-1}) and CS_1 (5.98 mg NH_4^+ released g^{-1} soil hr^{-1}) systems were found to be significantly superior over CS_5 (3.79 mg NH_4^+ released g^{-1} soil hr^{-1}).

A possible reason for the highest amount of urease activity under turmeric-based cropping system could be the higher application of FYM, which helped in the production of more root exudates therefore, higher urease activity. The higher urease activity in the legume-based system revealed that the significance of legumes to the increased availability of organic C and N and encouraged microbial activity. Khan,1970 and Wani *et al*. (2003). Elevated urease activity in legume-based cropping systems was also regulated by crop growth traits such as root development, nitrogen fixation and utilization pattern. Cereal and cotton crops have lower urease activity, which might be due to their deep roots and nutrient-rich nature. Velmourougane *et al*. (2013).

Generally, the aerobic conditions exhibited higher urease activity over flooded conditions. Under aerobic conditions, added residues were easily decomposed due to microbial activity, which helps in the mineralization of N and resulting in higher urease activity.

There was a significant variation observed at different soil depths. However, the higher activity was

recorded at 0-15 cm (6.60 mg NH_4^+ released g^{-1} soil h^{-1}) followed by 15-30 cm (6.29 mg NH_4^+ released g^{-1} soil h^{-1}) soil depths. The activity of urease was found to be lesser at 30-45 cm (5.78 mg NH_4^+ released g^{-1} soil h^{-1}).

The fundamental reason for the decline in enzyme activities with depth is the decline in biological function along the profile. The possible ways of explanation for the varying patterns of enzyme distribution with depth could be due to the less organic matter distribution, soil pH, reduced organic matter and microbial population in the deeper strata. Similar outcomes were revealed by Speir and Ross, (1978). There was no significant variation effect found among the treatment combinations of cropping systems and soil depths.

Table 1.3 : Effect of cropping systems with depth-wise variations on soil urease enzyme activity (µg NH_4-N g^{-1} hr^{-1}) in Northern Telangana Zone.

Cropping system	0-15 cm	15-30 cm	30-45 cm	Mean (CS)
CS_1	6.32	6.10	5.52	5.98
CS_2	7.60	7.34	7.04	7.33
CS_3	7.72	7.64	7.38	7.58
CS_4	6.56	6.52	6.24	6.44
CS_5	4.78	3.86	2.74	3.79
Mean (Depth)	6.60	6.29	5.78	
	S.Em±	**CD (5%)**	**CV (%)**	
CS	0.18	0.50	11.0	
depth	0.14	0.39		
CS X depth	0.31	NS		

*CS_1-Cotton-bengalgram, CS_2-Soybean-bengalgram, CS_3-Turmeric-Sesame, CS_4-Paddy- Paddy, CS_5- Paddy-Maize.

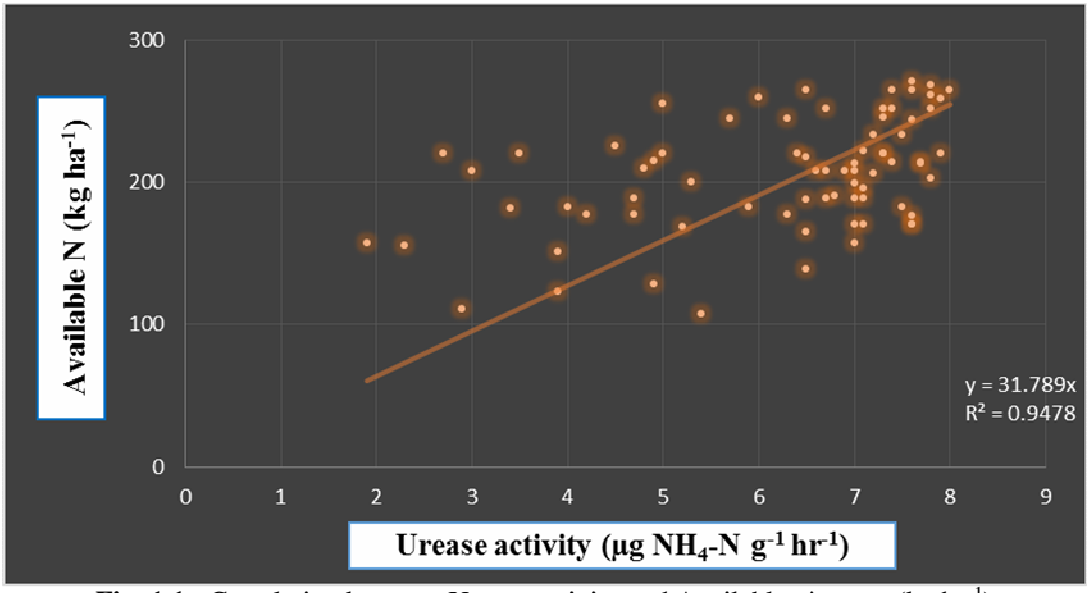

Fig. 1.1 : Correlation between Urease activity and Available nitrogen (kg ha^{-1})

A positive correlation has been noted between urease enzyme activity and available nitrogen R^2=0.94. With the increasing urease enzyme activity available nitrogen has improved. This is because the increased conversion of urea into ammonia and then ammonium is caused by greater urease activity, which raises the amount of nitrogen availability in the soil. Thus, increased microbial biomass in soils with elevated urease activity can aid in increasing nitrogen availability by breaking down organic nitrogen molecules. Li *et al.* (2008), Pang *et al.* (2009) and Gong *et al.* (2015).

Conclusion

The present study unveiled that the available nitrogen content in soils was recorded as low in status (184-228 kg ha^{-1}). The soil inorganic nitrogen fractions remarkably differed among the cropping systems. Among the cropping systems, significantly higher TN, NH_4-N^+ and NO_3-N^- were found under soybean-bengal gram cropping system (CS_2) (1269, 101 and 57.4 mg

kg^{-1}), which was on par with turmeric-sesame cropping system (CS_3) (1210, 95 and 53.8 mg kg^{-1}). The least TN, NH_4-N^+ and NO_3-N^- were noticed under paddy-maize cropping system (CS_5) (979, 81.8 and 46.4 mg kg^{-1}). The same trend was noticed under sub-surface soils too, with decreasing values down the depth.

Substantial variation under enzymatic activity *i.e.* dehydrogenase and urease were recognized. Significantly, the higher DHA and Urease were observed under turmeric-sesame cropping system (CS_3) (16.8 µg TPF g^{-1} d^{-1} and 7.58 mg NH_4^+ released g^{-1} soil h^{-1}, respectively) which, was on par with soybean-bengal gram cropping system (CS_2) (16 µg TPF g^{-1} d^{-1} and 7.33 mg NH_4^+ released g^{-1} soil h^{-1}, respectively). The least DHA and urease were recorded under paddy-maize cropping system (CS_5) (9.21 µg TPF g^{-1} d^{-1} and 3.79 mg NH_4^+ released g^{-1} soil h^{-1}, respectively). A similar trend with diminishing values down the depth was noted for DHA and urease. The relation between urease activity with available nitrogen was significantly positively correlated.

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