Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2582-2845.8731

ISSN: 2582 – 2845

Ind. J. Pure App. Biosci. (2021) *9*(3), 230-236

Indian Journal of Pure & Applied Biosciences

Peer-Reviewed, Refereed, Open Access Journal

Research Article

Kinetic of Nitrogen Mineralization by Using Various Organic Manures of Pune Region, Maharashtra

Subhash Singh[1]*, Roopali Patel[2] and Sonu Kumar[3]

[1,3]Division of Soil Science and Agricultural Chemistry, College of Agriculture, Pune, Mahatma Phule Krishi Vidyapeeth, Rahuri – 413 722, India

[2]Assam Agriculture University, Jorhat, Assam – 785013, India

*Corresponding Author E-mail: subhash2014.ss@gmail.com

Received: 18.03.2021 | Revised: 23.04.2021 | Accepted: 6.05.2021

ABSTRACT

The mathematical description of N mineralization in soils like parabolic model, exponential model, hyperbolic model, zero order models etc, is a possible 3 approach to characterize and quantify the organic matters pool and mineralization constant rate. The single exponential model most widely used for soil N mineralization, although other types have also been tested. Several kinetic models are often used to estimate the kinetic of N mineralization, thus a model is selected based on the highest coefficient of determination (r2) and the lowest standard error (Wijanarko & Purwanto, 2016). The N mineralization capacity through long term incubation procedures. From their studies they proposed an asymptotic model of time course of N mineralization, making it possible to calculate the N mineralization potential of the soils (Stanford & Smith, 1972). Kinetics parameters in mineralization study can be potentially used to access the mineralization-immobilization process in soils under varying environmental and management conditions. Nitrogen-use efficiency can be enhanced through the understanding of N-mineralization potential of different organic source.

Keywords: *Oragnic manure, N- mineralization, Kinetic equation.*

INTRODUCTION

In recent past, there is a renewal interest on the use of organic resources in agricultural for maintaining soil organic matter, improving soil quality and supplying plant nutrient for sustainable crop production. The use of organic waste in the amendment of agricultural soils can be beneficial for crops, and the same time, provide an efficient and cost effective method for its disposal. The organic fraction of manure can significantly increase soil aggregation, infiltration, microbial activity, structure, and water-holding capacity and can reduce soil compaction and erosion. Therefore, it gives real benefits of applying these organic materials to soil.

Cite this article: Singh, S., Patel, R., & Kumar, S. (2021). Kinetic of Nitrogen Mineralization by Using Various Organic Manures of Pune Region, Maharashtra, *Ind. J. Pure App. Biosci. 9*(3), 230-236. doi: http://dx.doi.org/10.18782/2582-2845.8731

This article is published under the terms of the Creative Commons Attribution License 4.0.

The determination of N mineralization potential in soil after organic amendments allows the evaluation of N dynamics in the soil and its true effectiveness in economic and ecological effect (Pedra et al., 2011). The incorporation of organic manures into soil is considered a good management practices because it stimulates soil microbial activity and increases soil fertility through mineralization. Inceptisol are in medium range of organic matter which is the backbone for the sustainability of soil fertility and productivity. An improved understanding of the competing processes of N mineralization and N immobilization, along with their temporal dynamic's, may improve our ability to manage N cycling, increase Nitrogen use efficiency (NUE) by minimizing N losses whatever the form, and increase the sustainability of agricultural system that utilize typically applied organic N sources (Cabrera et al., 2005).

Stanford and Smith (1972) were establishing the N mineralization capacity through long term incubation procedures. Kinetics parameters in mineralization study can be potentially used to access the mineralization-immobilization process in soils under varying environmental and management conditions. Nitrogen-use efficiency can be enhanced through the understanding of N-mineralization potential of different organic sources. The aim of present study was to determine and compare N mineralization rate, under laboratory condition amended with different organic residues in Inceptisol. The suitability of organic residues as a source of N depends to great extent on its mineralization of N in relation to crop demand.

MATERIALS AND METHODS

The present investigation was carried out to quantify the N mineralization rate of different organic manures in Inceptisol soil at field capacity moisture regimes (0.33 bar). A laboratory incubation experiment was carried out with (8 Treatment) eight organic manures thresee replication with CRD Design sources at Division of Soil Science and Agricultural Chemistry, College of Agriculture Pune-05, Maharashtra, during the year 2016-2017.

Materials

1. Soil-

Bulk soil (0-15cm) was obtained from the experimental farm (block-15B), of Agronomy Division, College of Agriculture Pune-05. The soil is an Inceptisol family of Typic Haplustept. Soil was air dried, in shade and grounded in wooden mortar and pastle, passed through 2 mm sieve and used for conducting the experiment. The physical and chemical characteristics of soil used are given in Table 1.

2. Organic manure

The eight value added organic manures were collected from different locations (Table 1) and used in the present laboratory incubation. Study the procedure of organic manures were passed through a 2 mm sieve and analyzed for further used.

Table 1: Oragnic manure

Treatment	Organic manure	Source
T_1	Farm Yard Manure (FYM)	Agronomy Division College of Agriculture
T_2	Vermicompost	College of Agriculture
T_3	Press mud cake Vasantdada Suger Institute	Manjari(BK)
T_4	Press mud compost Vasantdada Suger Institute	Manjari(BK)
T_5	Poultry manure Animal Husbandry and Dairy Science	College of Agriculture
T_6	Coco pit compost	College of Agriculture, Baramati
T_7	Urban compost Municipal corporation	Pune
T_8	Urban compost Municipal corporation	Pune
T_9	Spent mushroom compost AICRP	Mushroom Project

Fig. 1: Plate: Organic manure

Fig. 1. Plate 2: General view of N mineralization incubation study due to various organic manure sources

Statistical analysis

The data obtained in replicated experiments conducted were analyzed statistically by the methods described by Panse and Sukhatme (1967). All statistical analysis was performed with the help of programme prepared in Excel software.

Table 2: Kinetics equations used in the study

S.No.	Kinetic equations	Expression forms	References
1.	Zero order reaction	y = a +b x	Martin and Sparks(1983)
2.	First order reaction	y = a +b x	Martin and Sparks(1983)
3.	Second order reaction	1/y = a + b x	Havlin and westfall (1985)

Where,

y = mineralization of N (mg/kg)
x = time (h)
a = intercept
b = slope,

The cumulative data of mineralization of nitrogen (NH4-N + NO3-N) was used for the calculations of rate of mineralization and intercept. All statistical analysis was performed with the help of programme prepared in Excel software.

RESULTS AND DISSCUSSION

Coefficient of determination of zero order, first order and second order for NH4-N, NO3-N and NH4-N + NO3-N: Data pertaining to the Coefficient of determination of zero order, first order and second order kinetic model tested for periodical NH4-N, NO3-N and NH4- N+NO3-N release in inceptisol soils of College of Agriculture, Pune after additions of organic manures in Table 19 to 21, respectively. The above three kinetic equations were used to describe the kinetics of N Mineralization in inceptisol soil after addition of N @ 100 mg N kg-1 through various organic manures. The results of statistical analysis obtained by plot, which were fits between the equations and experimental data and calculated coefficient of determination (r2) release constant (a and b). The result showed that by using a zero order kinetic equations recorded the higher r2 values (r2 =0.974 to 0.984) in all the treatments in respect of NH4-N + NO3-N as compared with first order and second order kinetic equations. Zero order and first order kinetic equations are more suitable to describe N mineralization than second order kinetic equation. The Zero and first order kinetic equations recorded higher r2 value than second order equation has been recorded by the addition of organic manures in Typic Hapludults by Wijanarko and Purwanto (2016). Dou et al. (1996) also recorded similar result of N mineralization in respect of zero order and first order kinetic equation. Similar trend was also recorded in release of NH4-N and NO3-N (Table 19 and 20). It indicates that among the three equations zero order equation could be used for predicting the release pattern of forms of N released in inceptisol by the addition of organic manures. However, the second order equation is inferior as compared with zero and first orders model as it records the lower value of r2 in release of forms of N by the addition of various sources of organic manures.

Table 3: Intercept (a), slope (b) and coefficient of determination (r2) values for the kinetic equations of cumulative NH4-N as affected by various sources of organic manures

S.No.	Treatment		T_1 FYM	T_2 Vermicom- post	T_3 Press mud cake	T_4 Press mud com- post	T_5 Poultry manure	T_6 Coco-pit compost	T_7 Urban Compost	T_8 Spent mushroom compost	T_9 Control
	Kinetic equation										
1.	Zero order	a	22.19	25.41	21.22	24.53	42.36	19.79	25.99	21.06	18.54
	y = a + bx	b	1.65	1.81	1.59	1.75	2.21	1.51	1.90	1.62	1.33
2.		r^2	0.98	0.98	0.97	0.97	0.97	0.97	0.97	0.97	0.97
	First order	a	3.32	3.46	3.27	3.41	3.87	3.20	3.49	3.27	3.11
	y = a + b x	b	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
		r^2	0.87	0.88	0.87	0.87	0.86	0.86	0.88	0.87	0.86
3.	Second order	a	0.04	0.03	0.04	0.03	0.02	0.04	0.03	0.04	0.05
	1/y = a + b x	b	-0.0004	-0.0004	-0.0005	-0.0004	0.0430	-0.0005	-0.0004	-0.0005	-0.0006
		r^2	0.67	0.69	0.67	0.68	0.68	0.67	0.69	0.67	0.66

Mineralization N (NH4-N, NO3-N and NH4-N + NO3-N) release constants (a and b): The constants a and b of each equation represent the intercept and the slope of the linear curves resulting from plotting the mineralized N vs. time (Table 19 to 21) mineralization rate constants were calculated for Inceptisol soils using the zero-order, first-order and second-order equations by the addition of N @ 100 mg kg -1. The constant b mirrors the release rate of the mineralization of nitrogen (Simard & N"dayegamiye, 1993 & Pedra et al., 2011). The highest rate of mineralization (b= 6.14) and intercept (110.610) were 46 observed due to the addition of poultry manure for zero-order kinetic equations by the addition of poultry manure as compared with rest of the treatments and first order and second order equations and it was followed by vermicompost (Table 21). It attributes to the higher content of nitrogen in the original material. Control treatment observed the lowest values of rate constant and intercept in zero order equation. More or less similar rate constant values (-0.0001 to -0.0002) has been recorded in all the sources of organic manure and control treatment in case of second order mathematic model and these values were not affected by the addition of organic matter (Table 21). If higher negative values of b could be indication of inadequate mineralized N release from clay complex. The negative value of rate constants (b values) for potassium chloride was also reported by Ghiri and Jaberi (2013) in the release of kinetics of potassium. The much variation in intercept and rate constant was noticed in the zero order equation which was not observed in the first and second order equations. It might be because of the soil taxonomy, clay mineralogy, pH, CaCO3, adsorption, desorption, diffusion of the soils, and mathematical equations tested and quality of organic manures to be used for crop production. These results are in agreement with results obtained by Wijanarko and Purwanto (2016) but the higher values of rate and intercept was observed in this study. This might be because of initial rate of NH4-N released (a and b parameters) are dependent on clay content in soil.

The values of the rate constant (b values) obtained from soil samples after addition of various sources of organic manure could be used in combination with routine soil tests for predicting crop requirement for the N availability to crops. The lower b values of second-order (also referred as rate constant) were observed as compared with the values. The second-order equation (1/y = a + b x) had the least fit for predicting the mineralization rate.

Table 4: Intercept (a), slope (b) and coefficient of determination (r2) values for the kinetic equations of cumulative NO3-N as affected by various sources of organic manure

S.No.	Treatment		T_1 FYM	T_2 Vermi-compost	T_3 Press mud cake	T_4 Press mud com post	T_5 Poultry manure	T_6 Coco-pit compost	T_7 Urban Compost	T_8 Spent mushroom compost	T_9 Control
	Kinetic equation	a	52.57	56.51	42.01	53.92	68.24	32.48	60.18	47.19	30.72
1	Zero order	b	3.01	3.56	2.68	3.17	3.92	2.42	3.71	2.81	2.14
	y = a + b x	r^2	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
		a	4.12	4.24	3.93	4.17	4.41	3.72	4.30	4.02	3.64
2	First order	b	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	y = a + b x	r^2	0.88	0.89	0.88	0.88	0.89	0.88	0.89	0.87	0.88
		a	0.02	0.01	0.02	0.02	0.01	0.03	0.01	0.02	0.03
3	Second order	b	0.002	0.0002	0.0002	0.0002	-0.0001	-0.0003	-0.0002	-0.0002	-0.0003
	y = a + b x	r^2	0.69	0.71	0.69	0.70	0.71	0.69	0.71	0.68	0.69
		a	52.57	56.51	42.01	53.92	68.24	32.48	60.18	47.19	30.72

The results showed that the zero order equation constants also adequately described the kinetics of nitrogen amended with the various sources of organic manure in Inceptisol. The highest rate of mineralization (b= 6.14) and intercept (110.61) were observed due to the addition of poultry manure for zero-order mathematical model by the addition of poultry manure as compared with rest of the treatments (Table 21).

Table 5: Intercept (a), slope (b) and coefficient of determination (r2) values for the kinetic equations of cumulative NH4-N+ NO3-N as affected by various sources of organic manures

S.No.	Treatment		T_1 FYM	T_2 Vermi compost	T_3 Press mud cake	T_4 Press mud com-post	T_5 Poultry manure	T_6 Coco-pit compost	T_7 Urban Compost	T_8 Spent mushroom compost	T_9 Control
	Kinetic equation	a									
1.	Zero order	b	74.7	81.91	63.22	78.45	110.61	52.26	86.17	68.24	49.26
	y = a + b x	r^2	4.66	5.37	4.27	4.92	6.14	3.93	5.61	4.43	3.47
		a	0.98	0.98	0.98	0.98	0.98	0.97	0.98	0.98	0.98
2	First order	b	4.49	4.62	4.35	4.55	4.87	4.18	4.67	4.41	4.11
	y = a + b x	r^2	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
		a	0.87	0.89	0.88	0.88	0.88	0.87	0.89	0.87	0.87
	Second order	b	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02
3.	y = a + b x	r^2	0.0001	-0.0001	0.0002	- 0.0001	-0.0001	-0.0002	-0.0001	-0.0001	0.0002
		a	0.69	0.70	0.68	0.69	0.70	0.68	0.70	0.67	0.68

Summary and Conclusions

1. Coefficient of determination of zero order, first order and second order reactions for NH4-N, NO3-N and NH4-N + NO3-N: The result showed that by using a zero order kinetic equation recorded the higher r2 values (r2 =0.97 to 0.98) in all the treatments in respect of NH4-N + NO3- N as compared with first order and second order kinetic equations. Zero order and 55 first order kinetic equations are more suitable to describe N mineralization than second order kinetic equation. Mineralization N (NH4-N, NO3-N and NH4-N, NO3-N) release constants (a and b) of zero order, first order and second order reactions: The highest rate of mineralization (b= 6.137) and intercept (110.610) were observed due to the addition of poultry manure for zero-order kinetic equation by the addition of poultry manure as compared with rest of the treatments and first order and second order equations and it was followed by vermicompost. Control treatment observed the lowest values of rate constant and intercept in zero order equation. More or less similar rate constant values (-0.0001 to -0.0002) has been recorded in all the sources of organic manure and control treatment in case of second order kinetic equation and these values were not affected by the addition of organic matter. Zero order equation recorded the mean rate constant (b= 4.754) and intercept (73.875), respectively. The much variation in intercept and rate constant was noticed in the zero order equation which was not observed in the first and second order equations.

CONCLUSION

Among the different organic manures poultry manures recorded more values of NH4-N, NO3-N and NH4-N + NO3-N throughout the incubation period over rest of the treatments. The rate of release NH4-N was slow at 0 and 15 days after incubation and it was sharp increased a peak rate at 45 days of incubation fallowed by gradual decline thereafter in all organic manures amended treatments. 3. The application of all the sources of organic manures increased the potential N mineralization by 28.4 per cent to 80.10 per cent over the control. The potential N mineralization ranged from 3.27 to 5.89 mg kg-1 day-1 due to different treatment.

REFERANCES

Arps, J. J. (1944). Analysis of decline curv. Issued as T. P. 1758 in *Petrolium Technology, September.*

Cabrera, M. L., Kissel, D. E., & Vigil, M. F. (2005). Nitrogen mineralization from organic residues. *Journal of Environmental Quality 34*, 75-79.

Hazewinkel, M. E. D. (2001). "Linear equation". Encyclopedia of Mathematics, Springer, ISBN 978-1-55608-010-4.

Kumar, A., & Consul, P. C. (1979). Negative Moments of a Modified Power Series Distribution and Bias of the Maximum Likelihood Estimator. *Conmunications in Statistics*, *33*(2), 151–166.

Martin, H. W., & Sparks, D. L. (1983). Kinetics of nitrogen release from two coastal plain soils. *Soil Science Society of America Journal*, *47*, 883-887.

Panse, V. G., & Sukhatme, P. V. (1967). Statistical methods for agricultural workers. ICAR, New Delhi, 2nd Ed. pp. 96.

Pedra, F., Polo, A., Carranca, C., Ribeiro, A., & Domingues, H. (2011). Kinetics model fitted to nitrogen mineralization potential in soil amended with municipal compost and urban sewage sludge. Dynamic soil, Dynamic plant, Global science books.

Stanford, G., & Smith, S. J. (1972). Nitrogen Mineralization Potentials of Soils. *Soil science Society of America Journal*, *36*, 465–472.

Wijanarko, A., & Purwanto, B. H. (2016). Comparison of two kinetics models for estimating N mineralization affected by different quality of organic matter in Typic Hapludults. *Journal of degraded and mining land management*. ISSN: 2339-076x (e); 2502-2458 (p), *number 3*, 577-583.