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Kinetic Aspects of Nitrogen Loss in Presence of Ammonium Persulphate and Mixed Fertilizers in Soils

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Indian soils are generally deficient in organic matter and total nitrogen. To meet out nitrogen deficiency nitrogenous fertilizers are added to soils. All added nitrogen is not utilized by the crops and plants. All over the world farmers have observed that the recovery of nitrogen from fertilizers and maneuver in manure crop productions is usually low and of the order of 25-30 %. Nitrogen is lost through various ways such as erosions, leaching, gaseous loss denitrification and chemo denitrification. Soil erosion shows that the quantity of nitrogen removed in runoff water every year varies from 0.13 lb. to 0.53 lb per acre. It is evident that the nitrogen loss follows the first order non-reversible kinetic model in exposed sets (in light). However in covered sets (in dark) there is a departure from linearity. It is evident that the velocity constants are lower for mixed fertilizers than for nitrogen substance alone. The values of velocity constants for mixed fertilizers have been calculated only for the time period up to which the kinetic plots are linear representative. The average values of $K \times 10^3$ (d^{-1}) are 1.470 (± 0.12) in light and 2.359 (± 0.18) in dark for 0.2 % N + 1 % C + 0.5 % K and 0.25 % P concentrations. The average value of $K \times 10^3$ (d^{-1}) of 0.2 % concentration of nitrogen is 4.442 (± 0.36).

Key Words: Kinetic, Nitrogen loss, Ammonium persulphate, Mixed fertilizers.

INTRODUCTION

Nitrogen has been designated as growth element for plants and animals[1]. Several researchers[2-5] have shown that a good part of ammonium salets added to soil is lost without being used by plants and crops.

All the added nitrogen is not utilized by the crops[6]. A part of it is lost through various modes such as erosion, leaching, gaseous loss detoxification and chemo-denitrification[7]. All over the world, farmers have observed that the recovery of nitrogen by application of fertilizers and manures in

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crop production is usually low and is fertility of the order of about 25-30 % of the applied nitrogen[9]. Soil erosion shows that total quantity of nitrogen removed in run off water every year varies from about 0-13 lb to 0.53 lb per acre[10]. The nitrogen lost in exposed conditions is greater than that in covered conditions under comparable conditions. It is well established fact that the velocity of a chemical reaction increases with rise in temperature. The rate becomes doubled or trebled for each 10º rise in temperature.

It was considered worth while to study the kinetics of nitrogen loss using the experimental data obtained kinetically a lower values of the velocity constants would indicate a slower reaction and control of conditions so as to minimize the value of velocity constant would mean a reduction in the rate of nitrogen loss with respect to time.

The nitrogen added to soil is partly fixed and partly lost. It may therefore appear that a reversible kinetic model holds good for this process. The nitrogen fasciations is a usually a foster process and its loss is slower both depending on the nature and amount of nitrogen substances added and on other soil conditions.

EXPERIMENTAL

The rate expression for a first order reaction:

$A \longrightarrow$ is given by the equation rate = $\frac{-d(A)}{dt} = K(A)$

where (A) = concentration of A.

Rearrangement of the terms of the above equation and integrations give the equation:

$$K = \frac{2.303}{t} \log \frac{A_o}{A_{0-x}}$$

where, K = velocity constant of reactions, A_0 = Initial concentration of A, X = Number of moles of A reacting in time t so that concentration of A at time (t) is (A_{o-x}).

The standard deviations have been calculated using the expression:

$$\sigma = \left(\frac{(x_1 - \overline{x})^2 + (x_2 - \overline{x})^2 + \ldots\ldots\ldots + (x_n - \overline{x})^2}{n-1} \right)^{½}$$

where, σ = Standard deviations, $\overline{x}$ = Arithmetic mean of the calculated values of K, x_i = calculated values of K, n = number of values of K.

The calculated values of velocity constants and average values of K have been shown in Tables 1-3. Figs. 1-6 in parentheses show the standard deviation in their values.

TABLE-1
VELOCITY CONSTANT (K, d^{-1}) FOR NITROGEN LOSS
SOIL TREATMENT = 500 g SOIL + 0.2 % NITROGEN AS AMMONIUM PERSULPHATE AT AMBIENT TEMPERATURE

Conditions	Time (d)	Nitrogen loss (ppm)	$K \times 10^{-3}$ (d^{-1})	Average value (K d^{-1})
Light	0	246.5	-	3.457 ($\pm$0.16) $\times 10^{-3}$
	60	210.7	3.408	
	120	158.8	3.371	
	180	126.8	3.730	
Dark	0	246.5	-	2.560 ($\pm$0.25) $\times 10^{-3}$)
	60	208.9	2.717	
	120	177.9	2.751	
	180	156.2	2.530	

TABLE-2
VELOCITY CONSTANT (K, d^{-1}) FOR NITROGEN LOSS
SOIL TREATMENT = 500 g SOIL + 0.4 % NITROGEN AS AMMONIUM PERSULPHATE AT AMBIENT TEMPERATURE

Conditions	Time (d)	Nitrogen loss (ppm)	$K \times 10^{-3}$ (d^{-1})	Average value (K d^{-1})
Light	0	447.4	-	3.729 ($\pm$0.26) $\times 10^{-3}$
	60	357.5	3.761	
	120	283.7	3.817	
	180	220.2	3.944	
Dark	0	447.4	-	2.626 ($\pm$0.23) $\times 10^{-3}$
	60	377.8	2.253	
	120	318.3	2.888	
	180	282.6	2.560	

TABLE-3
AVERAGE VALUES OF VELOCITY CONSTANTS FOR NITROGEN LOSS USING MIXED FERTILIZERS AT AMBIENT TEMPERATURE

Mixed fertilizers	Concentrations	Average value condition of $K \times 10^{-3}$ (d^{-1})
APS + CNOC + KCl + DCP	0.2 % + 1 % C + 0.5 % K + 0.25 % P	2.128 (± 0.21) Light 1.569 (± 0.15) Dark
APS + MNOC + KCl + DCP	0.2 % N + 1 % C + 0.5 % K + 0.25 % P	1.862 (± 0.18) Light 1.366 (± 0.13) Dark

N = Nitrogen substance, C = Carbon as organic matter, K = Potassium as potassium chloride, P = P_2O_5 as Dicalcium phosphate.

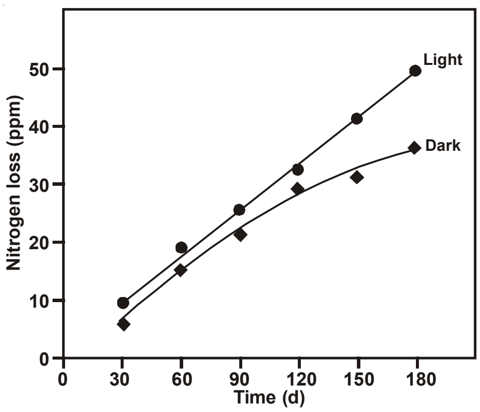

Fig. 1. Nitrogen loss with time for 0.2 % nitrogen as ammonium persulphate

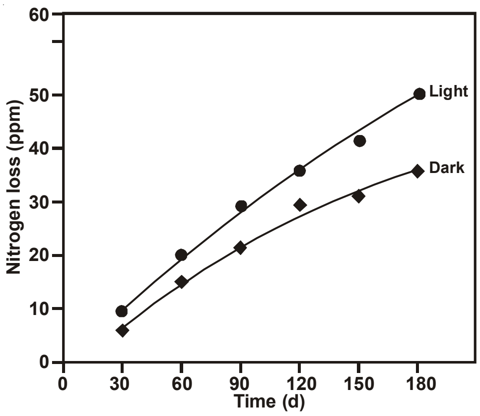

Fig. 2. Nitrogen loss with time for 0.4 % nitrogen as ammonium persulphate

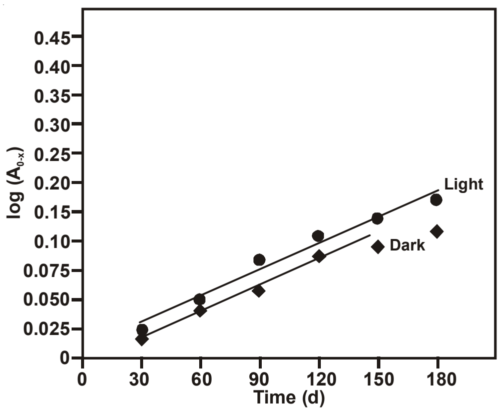

Fig. 3. A representative first order kinetic plot of nitrogen loss with mixed fertilizers

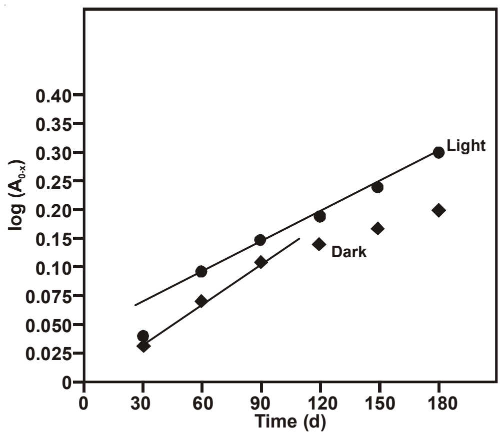

Fig. 4. First order kinetic plot of nitrogen loss with 0.4 % nitrogen as ammonium persulphate

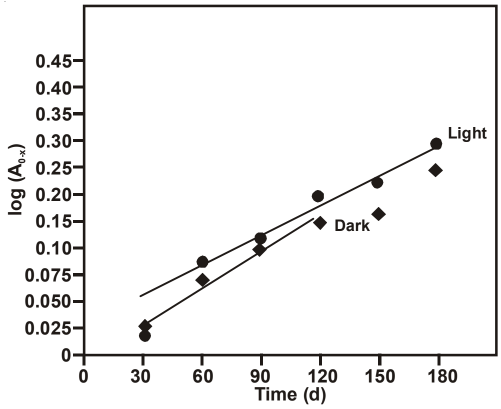

Fig. 5. First order kinetic plot of nitrogen loss with 0.2 % nitrogen as ammonium persulphate

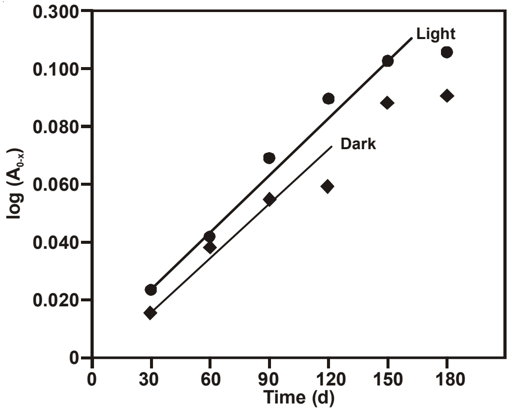

Fig. 6. A representative first order kinetic plot of nitrogen loss with mixed fertilizers

RESULTS AND DISCUSSION

Soil treatment with increasing amount of the nitrogen substances causes, in general, an increase in the values of K. It may also be noted in the case that the first order kinetic plots, particularly with higher doses of the nitrogen substances, do not pass through the origin indicating a high rate of nitrogen loss in the initial stages.

The first order kinetic plots when nitrogen substance is used along with organic matter, potassium and phosphorus is shown in Tables 1 and 2. In the case of mixed fertilizers the kinetic plots show a departure from linearity in light as well as dark sets[1-5]. These plots however appear to pass through the origin indicating that the rate of nitrogen loss in the case of mixtures is initially slower as compared to the case of nitrogen substance alone.

It is evident that the velocity constants are lower for mixed fertilizers then for nitrogen substance alone.

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