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# Studies on the nitrogen dynamics in soil and its requirement for paddy under INM system

**SISIR KUMAR SI**

*Vivekananda Institute of Biotechnology, Sri Ramakrishna Ashram, P.O. Nimpith Ashram, South 24-Parganas (Sundarbans)-743338, India*

The nitrogen use efficiency from fertilizer is low owing to its loss from soil through various chemical and biological processes under different land conditions (Sarker 1994). The organic source alone do not fulfill the nitrogen requirement of crops of higher nutrient demand due to low nutrient content and slow nutrient releasing capacity. Combined use of bio-fertilizer, manure and mineral fertilizer not only regulates nutrient supply to the crops but also checks nutrient losses and helps in buildup of soil fertility, when practiced over a period of time (Jarvis *et al*. 1996). The success of paddy production depends on judicious, efficient and economical use of different nitrogen sources which are much more knowledge-based and site-specific. In this context an attempt has been made to study the organic and inorganic nitrogen movement in paddy field to understand soil fertility change for better nitrogen management.

Field experiments were conducted during *kharif* season (2009) at five sites namely Naskarbandh (Golsi-I), Burdwan; Khanpur (Murrari-1), Birbhum; Gopalpur (Hanskhali), Nadia; Palpur (Gosaba), South 24-Parganas and Bahirchak (Patharprotima) South 24-Parganas of West Bengal with Ratna variety as test crop. The fields were divided into 8 blocks of 25 sq. meters. Nitrogen @ 60 kg $ha^{-1}$, Azolla @ 6 t $ha^{-1}$ (0.386 % N) and FYM @ 6 t $ha^{-1}$ (0.5% N) along with phosphorus @ 30 kg $ha^{-1}$ and potash @ 30 kg $ha^{-1}$ were applied The nitrogen input-output budget on paddy production was calculated by the following formula given by Dobermann and Fairhurst (2000). There were eight treatments consisting of Control; Fallow plot (budget equation, SN + 00= 00+ TL) ($T_1$); Control plot (budget equation, SN +00 = Up+ TL) ($T_2$); Fertilizer treated Fallow plot (budget equation, SN +ZF = 00+ TL) ($T_3$); Fertilizer treated Crop growing plot (budget equation, SN +ZF = Up+ TL) ($T_4$); *Azolla* treated Fallow plot (budget equation, SN +ZA = 00+ TL) ($T_5$); *Azolla* treated Crop growing plot (budget equation, SN +ZA = Up+ TL) ($T_6$); FYM treated Fallow plot (budget equation, SN +ZM = 00+ TL) ($T_7$); FYM treated Crop growing plot (budget equation, SN +ZM = Up+ TL) ($T_8$).

whereas indigenous Soil Nitrogen (SN) + Nitrogen addition Z (organic + inorganic + bio-fertilizer) = Up (nitrogen uptake by plant) + TL (Total nitrogen loss through volatilization, denitrification and leaching)

[Atmospheric deposited, Irrigation sediment etc. are ignored]

$$SN + Z = Up + TL \quad \text{——————————} (1)$$

The soil samples (0-15 cm) before transplanting and harvest of paddy were collected, air dried, ground and analyzed for available nitrogen (Subbiah and Asija 1956). Yields were recorded after harvest of paddy. Grain and straw samples were analysed for nitrogen and uptake was calculated (Chapman and Pratt 1961)

The N-use efficiency was calculated as follows:

I) Nitrogen Requirement (kg $kg^{-1}$) = Nitrogen uptake by plant, (kg $ha^{-1}$) / Crop yield (kg $ha^{-1}$)

II) % of contribution of soil nitrogen (CS) = Soil N Uptake (kg $ha^{-1}$) X 100 / Initial soil test nitrogen (ISTN) (kg $ha^{-1}$)

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III) % of contribution of fertilizer nitrogen (CF) = (Fert. N uptake –Soil N uptake) (kg $ha^{-1}$) X 100 / Amount of Fertilizer N (kg $ha^{-1}$) .

IV) % of contribution of *Azolla* nitrogen (CA) = (*Azolla*. N uptake –Soil N uptake) (kg $ha^{-1}$) X 100 / Amount of *Azolla* (kg $ha^{-1}$)

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V) % of contribution of FYM nitrogen (CM) = (FYM N uptake –Soil N uptake) (kg $ha^{-1}$) X 100 / Amount of FYM N (kg $ha^{-1}$)

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The nitrogen requirement (kg N $kg^{-1}$ grain) *i.e.* nitrogen uptake by paddy grain is a function of nitrogen supply from added different sources (Tandon 1994). Hence, combining the equations I, II, III, IV and V, we get the fertilizer dose as-

%CS X ISTN (kg $ha^{-1}$)+ %CF X Fertilizer dose (kg $ha^{-1}$) + %CA X amount of *Azolla* N (kg $ha^{-1}$) +%CM X amount of FYM-N (kg $ha^{-1}$) = 100 X Up X Constant (K). —— (2)

FYM-N (kg $ha^{-1}$) =. Weight of FYM in kg per hectare X 0.005

*Azolla*-N (kg $ha^{-1}$) = Weight of *Azolla* in kg per Sq. meter at time of incorporation X 10000 x 0.00368 in case of dual cropping

The validity of the formula was tested in farmers' fields in five locations using fertilizer doses of farmers practices, soil test based balanced fertilizer doses as well as balanced fertilizer dose substituting nitrogen 25% by *Azolla* and 25% by FYM using the above formula.

Initial and post harvest soil-N and grain yield of paddy in different treatments at five sites are presented in table 1. The values of ISTN in all sites indicate that these soils fall in low to medium fertility group (Ali 2005). The five sites, having different fertility level produced different yield of paddy in treatments. It was found that urea treated fields had higher amount of residual nitrogen than *Azolla* and FYM treated fields.

**Table 1**. Initial and post harvest soil test nitrogen (A)(kg $ha^{-1}$) and grain yield of paddy (B) (kg $ha^{-1}$)

| Location | ISTN (kg $ha^{-1}$) | $T_1$ | $T_2$ | | $T_3$ | $T_4$ | | $T_5$ | $T_6$ | | $T_7$ | $T_8$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Initial N | N at harvest | Grain yield | Initial N | N at harvest | Grain yield | Initial N | N at harvest | Grain yield | Initial N | N at harvest | Grain yield |
| BDW | 327.5 | 326.9 | 262.0 | 3119.0 | 342.5 | 307.0 | 4128.0 | 338.3 | 269.2 | 3813.0 | 335.6 | 283.8 | 3346.8 |
| BRB | 185.7 | 186.1 | 149.5 | 1936.4 | 198.5 | 196.6 | 2452.5 | 197.8 | 155.4 | 2302.0 | 197.2 | 168.0 | 2510.0 |
| NDA | 282.4 | 283.0 | 223.1 | 3041.0 | 296.4 | 169.2 | 3660.0 | 293.6 | 230.0 | 3205.0 | 291.5 | 243.9 | 3258.0 |
| PATH | 251.8 | 252.2 | 204.7 | 2140.4 | 264.1 | 252.4 | 2828.0 | 263.4 | 211.1 | 3091.0 | 262.7 | 223.7 | 2902.0 |
| GSB | 207.6 | 208.0 | 168.1 | 1972.0 | 219.6 | 216.6 | 2707.3 | 219.4 | 174.4 | 2846.0 | 217.9 | 189.9 | 2311.0 |

BDW: Burdwan; BRB: Birbhum; NDA: Nadia; PATH: Pathar prating; GSB: Gosaba

The difference between ISTN and PHSTN of plot $T_1$ and $T_2$ respectively reflected in soil nitrogen uptake by paddy from control plot ($T_2$). The nitrogen uptake by paddy from plots ($T_4$, $T_6$ and $T_8$) was calculated considering the difference between ISTN and PHSTN between the plots $T_3$ and $T_4$, $T_5$ and $T_6$, $T_7$ and $T_8$ respectively. Two parallel efficiency data were calculated from corresponding nitrogen uptake data (Table 2) and recorded in table 3.

**Table 2.** Nitrogen uptake by paddy

| Location | $T_2$ | | $T_4$ | | $T_6$ | | $T_8$ | |
|---|---|---|---|---|---|---|---|---|
| | A | B | A | B | A | B | A | B |
| BDW | 65.5 | 72.7 | 80.5 | 89.7 | 76.3 | 82.3 | 73.6 | 80.3 |
| BRB | 36.2 | 30.8 | 49.0 | 44.8 | 48.3 | 42.5 | 47.7 | 42.8 |
| NDA | 59.3 | 52.8 | 73.2 | 68.0 | 70.5 | 65.0 | 68.4 | 62.6 |
| PATH | 47.1 | 43.8 | 59.4 | 57.1 | 58.7 | 54.5 | 58.0 | 54.0 |
| GSB | 39.4 | 34.6 | 51.4 | 47.6 | 51.2 | 45.7 | 49.7 | 43.8 |

A) Obtained from experimental data B) Obtained from plant analysis

**Table 3.** Efficiency of soil, fertilizer, manure, azolla and average nitrogen requirement (kg N $ha^{-1}$ paddy grain)

| Location | % of Soil contribution | | % of Fert. contribution | | % of Azolla contribution | | % of FYM contribution | | NR-Aver. (kg N $ha^{-1}$ grain) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | A | B | A | B | A | B | A | B |
| BDW | 20.0 | 22.2 | 25.0 | 28.4 | 59.8 | 53.2 | 27.1 | 25.2 | 0.0206 | 0.0227 |
| BRB | 19.5 | 16.6 | 21.4 | 23.4 | 67.4 | 65.1 | 38.3 | 40.0 | 0.0197 | 0.0174 |
| NDA | 21.0 | 18.7 | 23.3 | 25.31 | 62.3 | 67.6 | 30.4 | 32.7 | 0.0209 | 0.0189 |
| PATH | 18.7 | 17.4 | 20.5 | 22.2 | 64.7 | 59.6 | 36.5 | 34.1 | 0.0205 | 0.0192 |
| GSB | 19.0 | 16.7 | 20.0 | 21.7 | 65.6 | 61.6 | 34.2 | 30.5 | 0.0196 | 0.0175 |

A: Obtained from experimental data B: Obtained from plant analysis

The parallel two sets of nitrogen uptake data of four treatments from five sites, obtained from two different approaches (Table 2) did not show significant difference.

The yield of paddy on farmers' field (farmers' practices) soil-test based recommendation and recommendations using the new formula (Table 4), it was found that the new formula recorded higher productivity through higher nitrogen use efficiency in practices at five sites.

**Table 4.** Average paddy yield under different approaches of nutrients management at five sites

| District | Block | Farmers No. | Recommendation | Nutrient (kg $ha^{-1}$) | | | Average Yield( kg $ha^{-1}$) |
|---|---|---|---|---|---|---|---|
| | | | | N | $P_2O_5$ | $K_2O$ | |
| Burdwan | Golsi-I | 11 | Farmers practice | 90 | 40 | 30 | 4755 |
| | | 5 | Soil test based | 70 | 35 | 35 | 4810 |
| | | 4 | INM (by formula) | --- | 35 | 35 | 4965 |
| Birbhum | Murrari-I | 10 | Farmers practice | 100 | 50 | 30 | 3790 |
| | | 7 | Soil test based | 80 | 45 | 45 | 3810 |
| | | 3 | INM (by formula) | --- | 45 | 45 | 4005 |
| Nadia | Hanskhali | 15 | Farmers practice | 97 | 35 | 25 | 4620 |
| | | 5 | Soil test based | 75 | 35 | 30 | 4670 |
| | | 5 | INM (by formula) | --- | 35 | 30 | 4860 |
| South 24-Parganas | Patharpratima | 20 | Farmers practice | 116 | 50 | 00 | 3710 |
| | | 11 | Soil test based | 80 | 40 | 20 | 3680 |
| | | 7 | INM (by formula) | --- | 40 | 20 | 4125 |
| South 24-Parganas | Gosaba | 21 | Farmers practice | 110 | 40 | 00 | 3640 |
| | | 9 | Soil test based | 80 | 40 | 20 | 3700 |
| | | 5 | INM (by formula) | --- | 40 | 20 | 4250 |

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**References**

Ali, J. (2005). Fertilizer recommendation for principal crops and cropping sequences of West Bengal, Booklet No. 1. Department of Agriculture, Government of West Bengal.

Chapman, H.D. and Pratt, P.F. (1961). Methods of analysis of soils, plant and waters, United States of America: Division of Agricultural Sciences, University of California.

Dobermann, A. and Farihurst, T.H. (2000). Rice-nutrient Disorder & Management, Potash and Phosphate Institute (PPI), Potash & Phosphate Institute of canada (PPIC) and International Rice Research Institute (IRRI).

Jarvis, S.C., Stockdate, E.A., Shepherd, M.A. and Paulson, D.S. (1996). Nitrogen mineralization in temperate agricultural soils: Processes and measurement. *Advances in Agronomy* **57**, 187-235.

Sarker, M.C. (1994). Fate of $^{15}N$ Urea applied to wheat grown under upland condition on a Typic Ustochrept. *Journal of the Indian Society of Soil Science* **42,** 267-271.

Subbiah, B.N. and Asija, G.L. (1956). A rapid procedure for the estimation of available nitrogen in soil. *Current Science* **25,** 259-260.

Tandon, HLS. (Ed.) (1994). Fertilizer Guide. Fertilizer Development and Consultation Organization, New Delhi, India, p. 79-93.

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