

COMPARISON OF KARANJIN WITH OTHER NITRIFICATION INHIBITORS FOR RETARDATION OF NITRIFICATION OF UREA N IN SOIL

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Key words

A.M. Dicyandiamide Inhibition Karanjin Nitrapyrin Nitrification Sandy clay loam

Summary

Comparative evaluation of Karanjin and three patented nitrification inhibitors for retardation of nitrification of urea in a sandy clay loam showed that the effectiveness of the compounds tested decreased in the order: Nitrapyrin > Karanjin > A.M. > dicyandiamide.

Introduction

Use of nitrification inhibitors hold promise for improving the efficiency of fertilizer nitrogen under situations where losses due to leaching and denitrification following nitrification are serious. These chemicals retard nitrification in soil thereby reduce the losses due to leaching and denitrification. The large body of literature on the use of nitrification inhibitors that has accumulated is the testimony to their growing importance in improving the efficiency of fertilizer nitrogen for crop production^{2, 3, 4, 7, 9}.

In an earlier communication we reported Karanjin, the major crystalline principle of karanja (*Pongamia glabra* Vent.) seed to be a promising inhibitor of nitrification in soil. Karanjin, a furano flavonoid compared well with Nitrapyrin (N-serve) in laboratory incubation tests and greenhouse pot studies with rice crop^{10, 11}. In the present study the ability of Karanjin to retard nitrification of urea N has been compared with those of other patented nitrification inhibitors like Nitrapyrin, A.M. and dicyandiamide.

Materials and methods

The soil used in the study was a surface (0–15 cm) sample of a sandy clay loam, alluvial soil collected from the farm of the Indian Agricultural Research Institute, New Delhi. The soil was air dried and

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Table 1. Analysis of soil

pH*	Organic C (%)	Total N (%)	NH ⁺ ₄ -N (µg/g soil)	NO ₃ -N (µg/g soil)	CEC (meq/100 g)	Sand (%)	Clay (%)	WHC** (%)
7.8	0.58	0.072	3	7	12.3	61	24	42

* 1:2.5 (Soil to water).

** Water holding capacity.

sieved through a 2-mm screen before use. Some important physiochemical properties of the soil are given in Table 1. Soil analyses was done as described earlier⁶.

The nitrification inhibitors tested were: Karanjin (3-methoxy furano-2, 3, 7, 8-flavone) obtained from the Karanja seed¹¹, Nitrapyrin 2-chloro-6-(trichloromethyl) pyridine, a patented product of Dow Chemical Co., Midland, Mich; USA; A.M. (2-amino-4-chloro 6-methyl pyrimidine), a nitrification inhibitor obtained from Toyo Koatsu Industries Inc. Tokyo, Japan and dicyandiamide (DCD).

All the compounds tested were added at the rate of the 5% concentration of urea N applied. Because of low solubility of Karanjin and Nitrapyrin in water these were dissolved in acetone (1 ml) and applied. The other compounds tested: A.M. and DCD were applied in aqueous solution. Equal amounts of acetone was added to control samples to equalise effect of acetone if any on nitrification.

Incubation procedure

The following incubation method was used for studying nitrification of urea as affected by different compounds. Ten g of soil sample were held in 125 ml conical flasks and treated with 1 ml of water/or 1 ml of water containing 1000 µg of urea N, and 50 µg (or 5% of urea N) of the nitrification inhibitors. The moisture content of the soil was brought to 50% water holding capacity (WHC) and the samples were incubated at 30°C. There were thus treatment of urea with and without the nitrification inhibitors along with appropriate controls. The soil samples in duplicate were analysed every other week for NH⁺₄, NO⁻₃, NO⁻₂ (ref¹²) and nitrification rates and inhibition of nitrification of urea N by different compounds were calculated as suggested by Sahrawat⁸. All the results are expressed on oven-dry soil weight basis.

Results and discussion

Nitrification of urea N was rapid and 90 per cent of applied urea was nitrified by 7 weeks. Addition of Nitrapyrin, Karanjin, A.M. and DCD retarded nitrification to varying degrees (Table 2). The maximum concentration of NO⁻₂ in all the treatments never exceeded 2ppm and so have not been reported. Nitrapyrin appeared to be the most potent nitrification inhibitor followed by Karanjin, A.M. and DCD. DCD was least effective among the four compounds tested. Nitrapyrin has been the most tested nitrification inhibitor and has proved quite effective (for examples see review by Prasad *et al.*⁴; Sahrawat⁸). DCD has been reported to be a nitrification inhibitor by many workers^{1,5}.

Bundy and Bremner¹ tested the effectiveness of 24 compounds proposed as nitrification inhibitors and found Nitrapyrin to be the most effective. But A.M. and DCD were reported to be quite less effective than Nitrapyrin. Reddy and Datta⁵ studied the retardation of nitrification of different forms of N fertilizers by DCD and reported that DCD was

Table 2. Effect of nitrification inhibitors on nitrification of urea N*

Treatment	1 week			3 week			5 week			7 week		
	NH ₄ ⁺ NO ₃ ⁻ N.R.**			NH ₄ ⁺ NO ₃ ⁻ N.R.			NH ₄ ⁺ NO ₃ ⁻ N.R.			NH ₄ ⁺ NO ₃ ⁻ N.R.		
Urea alone	51	30	37	20	65	76	15	73	83	99	82	90
Urea + Nitrapyrin	72	8	10	68	15	18	56	28	33	39	54	58
Urea + Karanjin	68	12	15	60	24	28	51	36	41	32	61	66
Urea + A.M.	65	16	20	55	30	35	46	41	47	23	70	75
Urea + DCD	61	20	25	51	35	41	38	50	57	20	75	79

* Urea was applied at the rate of 100 ppm N and the inhibitors were added at the rate of 5% of urea N (or 5 ppm of soil). The values of NH₄⁺ and NO₃⁻ presented are the net amounts from urea and the amounts of mineral N in control (no urea applied) have been subtracted at each sampling.

** N.R.: Nitrification rate, % = $\frac{(\text{NO}_3^- - \text{N})}{(\text{NH}_4^+ + \text{NO}_3^-) - \text{N}} \times 100$.

less effective with ammonium sulfate than with urea N. The maximum present inhibition of nitrification in a sandy loam by DCD calculated from their data appears to be only 50% when this compound was added at 5 and 10 ppm concentration to urea during 10 weeks of study. In this study, maximum inhibition of nitrification by the compounds tested were: Nitrapyrin, 76%; Karanjin, 63%; A.M., 54% and DCD 46% (Table 3).

The results of this study again bring out the effectiveness of karanjin nitrification inhibitor and corroborate our earlier findings where karanjin was compared with Nitrapyrin and was reported to give matching performance with Nitrapyrin¹¹. The effectiveness of the compounds proposed as nitrification inhibitors decreased in the order: Nitrapyrin > karanjin > A.M. nitrification inhibitor > DCD. The nitrification rates of urea with Nitrapyrin, Karanjin, A.M. and DCD treated soil after 7 weeks were respectively 58, 66, 75 and 79 per cent as compared to 90 per cent nitrification rate obtained in urea without inhibitor treatment (Table 2).

Table 3. Inhibition of nitrification by different compounds

Nitrification inhibitor	% inhibition of nitrification after weeks*			
	1	3	5	7
Nitrapyrin	73	76	60	36
Karanjin	60	63	51	27
A.M.	46	54	43	17
DCD	32	46	31	12

* % Inhibition of nitrification⁸

$$= \frac{(\text{Nitrification rate of urea alone}) - (\text{Nitrification rate of inhibitor-treated urea})}{(\text{Nitrification rate of urea alone})}$$

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