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ON THE CRITERIA FOR COMPARING THE ABILITY OF COMPOUNDS FOR RETARDATION OF NITRIFICATION IN SOIL

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Key words

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Summary

Evidence has been presented to show that the effectiveness of compounds as nitrification inhibitors is better compared using the criterion of percent inhibition of nitrification, when the soil samples not treated with the nitrification inhibitors do not contain any significant amounts of ammonium nitrogen. The criterion based on nitrification rates of soil samples with and without nitrification inhibitor treatments has been proposed for comparing the ability of the compounds in retarding nitrification when the incubated soil samples contain significant amounts of ammoniumnitrogen. Examples have been cited in support of the proposed criterion.

Use of nitrification inhibitors hold promise for improving the efficiency of fertilizer nitrogen under situations, where nitrate formation results in severe losses due to leaching and denitrification. During the past 15 years, a vast array of compounds including pesticides have been proposed for retarding nitrification in soils, which is testimony to the wide spread interest in this aspect of research for improving the efficiency of fertilizer nitrogen[2,3,4,5,6].

Since a large number of compounds need to be evaluated for their ability to retard nitrification in soils to select specific and efficient types of nitrification inhibitors, it becomes imperative to have some criteria that could be employed for comparing the effectiveness of the proposed nitrification inhibitors. Because sometimes presentation of results becomes very space consuming when the values for NH_4^+, NO_2^-, and NO_3^-–N are used for comparison and the comparisons are also not very effective especially when a large number of compounds are evaluated. There is thus an obvious need for simple criteria, which could be used for evaluation and comparison of the effectiveness of various compounds proposed as nitrification inhibitors.

Recently, Bundy and Bremner[1] evaluated the effectiveness of 24 compounds proposed as inhibitors of nitrification using the criterion of percent inhibition of nitrification in soils. Percent inhibition of nitrification was calculated from: $(C-S)/C \times 100$, where S = amount of (nitrite + nitrate) – N produced in the soil sample treated with the test

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compound and C = amount of (nitrite + nitrate) – N produced in the control (no test compound added). These authors chose the time of soil sampling so that no NH_4^+–N could be detected in soil samples that had not been treated with nitrification inhibitors. However, this criterion, may have to be changed to some other criterion, when the incubated soil samples have significant amounts of NH_4^+ in addition to NO_2^- and NO_3^-–N. The purpose of this communication is to present evidence to show that when the soil samples contain relatively higher amounts of NH_4^+ it may be useful to employ the nitrification rates of soils with and without a nitrification inhibitor as the criterion for comparing the effectiveness of the compounds proposed as nitrification inhibitors. Nitrification rates are calculated from the values of NH_4^+, NO_2^- and NO_3^- obtained from soil analysis, using the formula[10].

$$\text{Nitrification rate, \%} = \frac{(NO_2^- + NO_3^-) - N}{(NH_4^+ + NO_2^- + NO_3^-) - N} \times 100$$

Examples in support of this observation have been cited from the data of Sahrawat[7,8] and Sahrawat and Mukerjee[9]. Inhibition of nitrification by Nitrapyrin (2-chloro-6-(trichloromethyl) pyridine), karanjin and biuret at 5% concentration of the nitrogen rate are calculated from the data shown in Table 1 using the criteria of Bundy and Bremner[1] and that of Sahrawat *et al.*[10].

Table 1. Data used for calculation of inhibition of nitrification of urea nitrogen in soils by biuret, karanjin and Nitrapyrin

Treatment		Inorganic nitrogen, ppm after weeks		
		1	3	5
Urea (100 ppm N)	NH_4^+	53	13	4
	NO_2^-	4.4	1.0	0.0
	NO_3^-	30	66	90
Urea + 5% biuret	NH_4^+	69	36	12
	NO_2^-	14.4	7.8	3.0
	NO_3^-	9	43	76
Urea (200 ppm N)	NH_4^+	94	36	15
	NO_2^-	0.8	1.6	0.0
	NO_3^-	18	87	131
Urea + 5% Karanjin	NH_4^+	170	120	33
	NO_2^-	0.7	1.2	0.3
	NO_3^-	5	24	62
Urea + 5% Nitrapyrin	NH_4^+	175	132	42
	NO_2^-	0.5	0.5	0.7
	NO_3^-	4	18	45

(Source: Sahrawat[7,8] and Sahrawat and Mukerjee[9]).

Table 2. Comparison of the two criteria for evaluation of effectiveness of nitrification inhibitors for retardation of nitrification of urea N in soil

Nitrification inhibitor	Criteria used for calculation of inhibition of nitrification	Percent inhibition of nitrification after weeks		
		1	3	5
Biuret	Bundy and Bremner[1]	32	24	12
Biuret	Sahrawat (proposed)	36	30	9
Karanjin	Bundy and Bremner[1]	70	72	52
Karanjin	Sahrawat (proposed)	81	76	27
Nitrapyrin	Bundy and Bremner[1]	76	79	65
Nitrapyrin	Sahrawat (proposed)	85	83	42

Percent inhibition of nitrification was calculated (i) by using the values of NO_2^- and NO_3^- produced in the soil samples using the criterion of Bundy and Bremner[1] and (ii) from the values of NH_4^+, NO_2^- and NO_3^-, nitrification rates of urea with and without the test inhibitors were calculated from the nitrification rate equation and then percent inhibition of nitrification were obtained from the following formula:

$$\% \text{ Inhibition of nitrification} = \frac{\text{Nitrification rate in control-nitrification rate in inhibitor treated sample}}{\text{Nitrification rate in control}} \times 100$$

A perusal of the results shown in Table 2, reveals that the criterion of Bundy and Bremner[1] gave lower values for inhibition of nitrification after one week but gave higher values after 5 weeks of incubation as compared to the criterion based on nitrification rates suggested by Sahrawat *et al.*[10]. The lower values for inhibition of nitrification by the criterion of Bundy and Bremner[1] were due to presence of significant amounts of NH_4^+–N in soil samples not treated with the nitrification inhibitors[7,8,9] (also see Table 1). Because in this case only the amounts of NO_2^- and NO_3^- present in the soil samples are used for calculating the inhibition of nitrification. Whereas in calculating the nitrification rates, the amounts of NH_4^+ present in soil samples are also taken into consideration in addition to the amounts of NO_2^- and NO_3^- and thus this criterion gave higher values for inhibition of nitrification, when significant amounts of NH_4^+ were present in soil samples. It has been further observed that if the total amounts of inorganic N present in soil samples with and without the inhibitor treatments are same, both the criteria give some values for inhibition of nitrification. But when the amounts of inorganic nitrogen in the inhibitor treated soil samples is not the same as in the untreated samples the two criteria give different values for percent inhibition of nitrification as shown in Table 2.

It thus becomes evident from the above discussion that for evaluating compounds for retarding nitrification in soil, the criterion of Bundy and Bremner[1] is useful when the soil samples not treated with nitrification inhibitors do not contain significant amounts of NH_4^+, whereas the criterion of nitrification rates proposed as suggested by Sahrawat *et*

al.[10], may give a better estimate of the inhibition of nitrification by compounds if significant amounts of NH_4^+–N is present in soil samples and there is an obvious need to test these criteria with more studies.

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