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Effect of urea, vermicompost and pendimethalin on nitrogen transformation in lateritic soil

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ABSTRACT

An experiment was conducted to study the effect of pendimethalin on nitrogen transformation of vermicompost and urea in lateritic soil of West Bengal. There was continuous decrease in NH_4^+N content in soil, irrespective of treatments. The rate of decrease was gradual during the initial period (up to 3rd week), while it was sharp during the later part of incubation. NO_3^-N content showed a decreasing trend up to 4th week of incubation both in control and urea treated soil, irrespective of pendimethalin application. Thereafter, there was a sharp increase. However, such decrease in NO_3^-N content was not observed during the initial period in soil where vermicompost was applied. The results also suggest that on an average, vermicompost was as efficient as urea in releasing NO_3^-N. The mean results indicated that the urea treatments released much higher amount of mineral nitrogen (NH_4^+N + NO_3^-N) compared to vermicompost.

Key words : Nitrogen transformation, Urea, Vermicompost, Pendimethalin, Lateritic soil.

Proper synchronization of nutrient release and crop uptake need a detailed study of nutrient mineralization behaviour from different sources. It is especially important for nitrogen which is subjected to different avenues of loss and hence, difficult to hold in soil. Nitrogen mineralization is a biochemical process mediated by different soil microorganisms. With advancement of agricultural technology, use of herbicide is now-a-days a common practice to manage weeds to get higher production and profit. Pendimethalin is such a soil applied herbicide and is widely used to manage weeds in more than forty crops. However, this chemical may alter the balanced soil ecology and result into altered mineralization pattern (Shukla and Mishra 1997, Debnath *et al.* 2002, Lin *et al.* 2003). Literatures are available citing the effect of soil applied herbicides on soil microbial community but information regarding the effect of these chemicals on the resultant soil biochemical processes, mainly on nitrogen transformation processes is vary scanty. Hence, an experiment was conducted to study the effect of pendimethalin on nitrogen transformation under two sources of nitrogen both organic and inorganic, namely, vermicompost and urea in lateritic soil of Birbhum district of West Bengal.

MATERIALS AND METHODS

The experimental soil was collected from Sriniketan, Birbhum (West Bengal) representing red and lateritic soils and analyzed for its physico chemical properties following standard procedures (Jackson 1973). The soil was sandy loam in texture having pH 6.44, organic carbon content 3.30 g/kg, NH_4^+N and NO_3^-N contents 32.90 and 12.54 mg/kg soil, respectively. Twenty five gram air dried soil samples were taken in a number of wide mouth glass incubation tubes and the soils were treated with two sources of nitrogen, namely urea and vermicompost at the rate of 100 kg N/ha and two levels of pendimethalin *i.e.*, 0 and 0.5 mg/kg in all possible combinations. A control was also maintained for both the levels of pendimethalin. Total weight of each bottle was recorded after treatment application. Moisture content in the soil was maintained at field capacity by weighing every tube daily. The experiment was conducted in a completely randomized factorial design with three replications. The soil samples were collected at 1, 2, 3, 4, 5, 6, 7 and 8 weeks after incubation and analyzed for NH_4^+N and NO_3^-N following methods as described by Jackson (1973).

RESULTS AND DISCUSSION

The results indicated the continuous decrease in NH_4^+N content in soil, irrespective of treatments (Table 1). The rate of decrease was gradual during the initial period (up to 3rd week), while it was sharp during the latter part of incubation. Urea treated soils maintained higher values of NH_4^+N as compared to vermicompost treatment throughout the incubation period, both in presence and absence of

Table 1. Effect of urea, vermicompost and pendimethalin on NH_4^+N content in soil

	Incubation period (weeks)									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Mean**
					Without pendimethalin					
Control	32.90	31.45	30.16	20.05	10.24	25.04	19.27	16.07	7.05	21.36
Urea	57.71	54.38	56.80	35.36	31.46	29.73	21.49	14.18	8.05	34.35
Vermicompost	23.48	26.28	30.10	9.46	12.18	12.02	7.02	8.14	4.30	14.77
Mean	38.03	37.37	39.02	21.62	17.96	22.26	15.93	12.79	6.46	23.49
					With pendimethalin					
Control	30.60	23.90	22.52	19.44	18.25	17.24	16.98	10.58	5.06	18.28
Urea	56.14	54.27	56.81	26.50	28.15	24.51	28.78	15.48	9.31	33.33
Vermicompost	28.21	23.75	20.54	13.66	13.34	9.11	12.34	7.98	8.84	15.31
Mean	38.32	33.97	33.29	19.87	19.91	16.95	19.37	11.35	7.73	22.31
Mean	38.18	35.67	36.15	20.74	18.93	19.61	17.65	12.07	7.97	
LSD (P=0.05)	Time 1.29	Level of pendimethalin 0.61		Nitrogen source x level of pendimethalin 1.05		Time x level of pendimethalin 1.82		Time x nitrogen source x level of pendimethalin 3.16		

Table 2. Effect on urea, vermicompost and pendimethalin on NO_3^-N content in soil

Treatments	Incubation period (weeks)									**Mean**
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
					Without pendimethalin					
Control	12.54	12.89	12.27	8.82	6.06	34.19	23.97	21.35	21.15	17.02
Urea	15.35	12.62	13.96	10.52	8.92	28.76	25.31	33.55	37.90	20.76
Vermicompost	16.64	17.74	16.73	17.50	17.33	19.69	23.58	30.65	30.50	21.15
Mean	14.84	14.42	14.32	12.28	10.77	27.54	24.28	28.52	29.85	19.65
					With pendimethalin					
Control	13.61	18.64	15.49	9.21	8.03	14.1	18.72	21.65	18.35	15.31
Urea	16.73	21.22	12.25	12.05	11.93	24.02	28.4	36.1	33.5	21.80
Vermicompost	16.06	21.34	21.02	25.67	21.64	13.06	22.27	30.55	28.95	22.28
Mean	15.47	20.40	16.25	15.64	13.87	17.06	23.13	29.43	26.93	19.80
Mean	15.16	17.41	15.29	13.96	12.32	22.30	23.71	28.98	28.39	
LSD (P=0.05)	Time 0.60		Level of pendimethalin 0.28		Nitrogen source x level of pendimethalin 0.48		Time x level of pendimethalin 0.83		Time x nitrogen source x level of pendimethalin 1.41	

pendimethalin. This favourable effect of urea might be due to hydrolysis of urea and subsequent release of NH_4^+N. During the initial period, pendimethalin application caused significant decrease in NH_4^+N content in vermicompost treated soil. However, such inhibitory effect was not observed at the end of incubation period. This might be due to adverse effect of the herbicide on ammonifying bacteria which was recovered after complete degradation of the herbicide. Shukla and Mishra (1997) also reported the inhibitory effect of the herbicide on ammonification. Another reason might be, as reported by Lin *et al.* (2003), the stimulating effect of pendimethalin on nitrifying bacteria which resulted in immediate formation of nitrate leading to reduction in NH_4^+N.

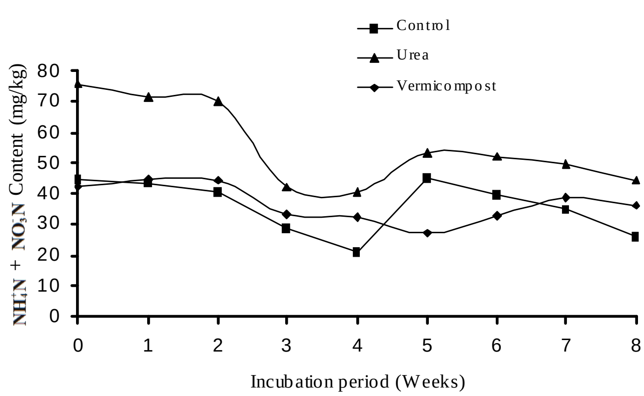

Fig.1 Effect of urea and vermicompost on NH_4^+N + NO_3^-N content (mg/kg soil).

NO_3^-N content showed a decreasing trend up to 4th week of incubation both in control and urea treated soil, irrespective of pendimethalin application (Table 2). Thereafter, there was a sharp increase. However, such decrease in NO_3^-N content was not observed during the initial period in soil where vermicompost was applied. Moreover, vermicompost maintained somewhat higher level of NO_3^-N during the initial period when compared with urea. Application of pendimethalin caused increased liberation of NO_3^-N during the initial period of incubation from both the sources of nitrogen, but at later period, the effect of the herbicide was not so prominent. Enhanced nitrification due to herbicide application was also reported by Debnath *et al.* (2002). Similar favourable effect of pendimethalin at lower rate on the microbial activity during initial period was also reported by Lin *et al.* (2003). The results also suggest that on an average, vermicompost was as efficient as urea in releasing NO_3^-N.

The mean results indicated that the urea treatments released much higher amount of mineral nitrogen (NH_4^+N+ NO_3^-N) compared to vermicompost (Fig.1). However, with an organic source like vermicompost, a steady release of the mineral nitrogen was observed throughout the incubation period. Thus, the results suggested that organics can supply mineral nutrients throughout the cropping period and may minimize nutrient loss by its controlled release mechanism. Considering the apparent net mineralization (mineral N in treated soil – mineral N in control at the same incubation period) of nitrogen in different incubation periods, it was observed that there was a continuous immobilization of native soil nitrogen where the nitrogen source was vermicompost (Fig.2). The amount immobilized was observed to be highest at 6th week. Similar immobilization of nitrogen was also reported by Singh and Aulakh (2001) and Gupta *et al.* (2003). However, pendimethalin application counteracted the immobilization and favoured mineralization in vermicompost treated soil. Pendimethalin also increased the net nitrogen mineralization in urea treated soil.

The study thus, revealed that NH_4^+N content was decreased with time. Application of pendimethalin further decreased the NH_4^+N contents in soils and the effect of pendimethalin was more pronounced during initial stages of incubation. NO_3^-N contents, however, increased with time. There was a favourable effect of the herbicide on nitrate formation. Pendimethalin also checked the immobilization of native nitrogen due to application of vermicompost in soil.

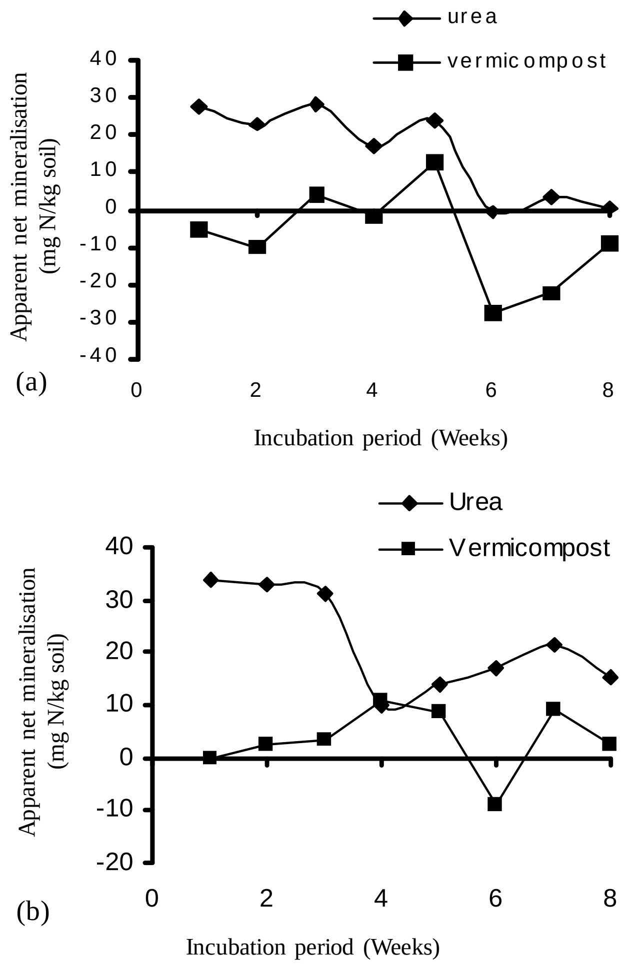

Fig 2. Apparent net nitrogen mineralization (mg N/kg soil) without (a) and with (b) application of pendimethalin

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