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SHORT COMMUNICATION

Improvements in the method for the determination of ammonia volatilised from soil fertilized with urea

Summary

The use of a closed system to measure the loss of nitrogen by volatilisation from urea applied to soil has resulted in very high values. The experimental unit described in this paper uses a modified aerated system which gives results in close agreement with yield data. These results, obtained under laboratory and fields conditions, are discussed.

Introduction

Urea is being increasingly used as a nitrogenous fertilizer because of its high nitrogen content as compared to ammonium sulphate and the added advantage that continued application does not markedly affect the pH of soils [1].

The soil urease enzyme converts urea very rapidly to ammonium carbonate. The possible loss of ammonia derived from the ammonium carbonate particularly at the alkaline pH prevailing on the decomposing surface litter and organic matter near the soil surface has been cited as a particular disadvantage of using urea as a fertilizer [2].

The technique first described by Volk [3] and modified by Watson *et al.*[4] has been used to measure the loss of urea nitrogen from tea soils and losses as high as 30–40 per cent have been reported.[2] These losses are however at variance with the data obtained from statistically laid out field experiments where it was found that application of nitrogen as urea resulted in yields which were almost comparable to those obtained using ammonium sulphate and any occasional drop in yield seldom exceeded 10% of that obtained with ammonium sulphate [1].

In this part of the paper the results obtained by using the system described earlier [3 4] are compared with the results obtained by the use of a new improved system which gives results in closer agreement with those expected on the basis of yield data.

Materials and methods

Soil samples. The soils used in laboratory studies were obtained from cultivated tea fields at Talawakele (1500m amsl) in Sri Lanka.

Samples for measurement of surface loss of ammonia were collected as 20 cm cube slabs from an undisturbed tea soil surface and brought to the laboratory. The slabs were suitably cut and placed to half fill a large desiccator (24 cm diameter).

Urea. Urea was applied to the soil at the rate of 5g/734 sq cm (equivalent to approx. 300 kg urea-N/ha). Titratable quantities of ammonia were generally found to be evolved from the fourth to sixth day onwards.

Soil surface reactions

1. Closed system. The system was similar to that described earlier [3 4] and consisted of filter paper discs saturated with 0.5 *N* sulphuric acid suspended on a glass tripod 2.5 cm above the surface of the soil contained in the desiccator. The desiccator was kept closed after the application of the calculated quantity of urea to the soil surface. The ammonia absorbed by the filter paper was determined by soaking the filter paper in distilled water and titrating with 0.1 *N* borax.

2. Aerated system. The calculated quantity of urea was evenly applied on the surface of the soil in the desiccator and this was covered with the lid carrying outlet and inlet tubes (Fig. 1).

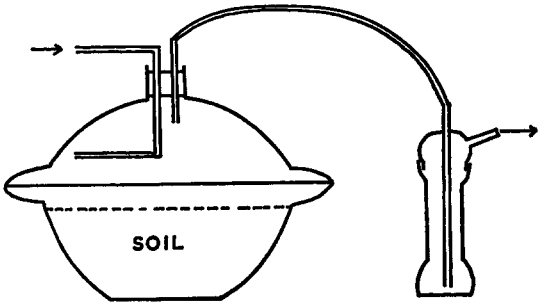

Fig. 1. Aerated system.

Air was either passed through the system from a compressed-air source or using a low-pressure vacuum pump. The ammonia released over the soil surface was carried in the air stream and trapped in either 4% boric acid or 0.5 *N* sulphuric acid contained in a gas washing bottle. Precautions were taken to ensure that the quantity of acid was sufficient to trap all the ammonia evolved. The soil was periodically moistened to ensure that there was no desiccation. The quantity of ammonia released after a given interval was determined by titration with 0.1 *N* hydrochloric acid in the case of boric acid or 0.1 *N* borax in the case of sulphuric acid.

3. Field experiments. The experiments under field conditions were carried out by placing the desiccator lid, with or without an arrangement for aeration, on the soil surface with the edges buried to about 2 cm so that there was no air leakage. In certain experiments the tea plants were fully pruned so

that the experimental areas are exposed to full sunlight. Other experiments were carried out in the partial shade under the plants.

Results

It is evident from Tables 1a and 1b that, throughout the progress of the experiment, the closed system shows higher values for the loss of nitrogen by volatilization as ammonia when compared to the aerated system. The presence of surface litter on the soil caused an increased evolution of ammonia (Table 1b).

TABLE 1

The loss of nitrogen (mg NH_4–N) from urea applied to soil. Laboratory experiment

No. of days after urea application	Closed	Aerated
a. Soil free of surface litter		
6	7.56	2.81
8	7.98	2.99
10	9.10	5.29
12	7.84	4.23
15	8.96	2.74
Percent of applied urea N lost	1.84	0.80
b. Soil with surface litter		
4	45.22	9.32
7	48.02	10.64
9	20.16	4.76
11	14.70	11.76
16	27.02	9.83
Percent of applied urea N lost	6.89	2.16

In a field where the plants were pruned to ensure very even distribution of sunlight the closed system again gave higher values for the loss of nitrogen (Table 2). The results from duplicate experiments are comparable.

Table 3 gives the values for the progressive loss of ammonia when the experiment was carried out under the partial shade of the tea plants. The variable values obtained were generally found to be associated with the uneven distribution of sunlight. Direct sunlight falling on the experimental unit caused a greater evolution of ammonia.

TABLE 2

The loss of nitrogen from urea in the field (*unshaded*). (units – mg ammonium nitrogen)

No. of days after urea application	Aerated 1	Aerated 2	Closed 1	Closed 2
4	37.24	26.04	57.38	40.18
6	16.24	13.28	66.64	66.50
8	5.88	11.08	66.64	65.38
10	13.86	14.28	101.64	78.54
13	21.14	18.90	61.32	56.00
15	17.22	25.90	35.42	28.98
17	6.62	10.08	25.00	22.26
Percent of applied urea N lost	5.26	5.27	17.72	15.91

TABLE 3

Loss of nitrogen from urea in the the field (*partially shaded*). (units – mg ammonium nitrogen)

No. of days after urea application	Aerated 1	Aerated 2	Closed 1	Closed 2
6	1.86	13.41	61.46	37.66
8	2.28	8.74	36.26	11.20
10	5.22	9.06	25.90	11.20
12	14.32	11.24	25.06	9.52
15	11.90	12.32	15.54	14.14
Percent of applied urea N lost	1.58	3.06	7.29	3.73

Discussion

The continuous flow of a gentle stream of air over the surface of the soil being studied ensures that the micro-environment inside the system is comparable to the normal exposed soil surface. This assumption is substantiated by the finding that the loss of nitrogen measured by this system, being not much higher than 5 per cent of the total urea nitrogen applied (Table 2), is in general agreement with that expected from yield data obtained in field experiments [1].

The data obtained from use of the experimental unit described in this paper would facilitate the prediction of yield losses on the basis of observed losses of ammonia from the soil surface. The technique could be further used in the evaluation of soil types where it is intended to use urea as a source of nitrogen. Great care has to be exercised to ensure that the experimental conditions are as close as possible to those prevailing in the field. Any biological variation inherent in the soil and its environment has also to be taken

into account in interpreting the results. Final confirmation of the findings can be obtained only from field trials of the conventional design.

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References

1 Bhavanandan, V. P. and Sunderalingam, S., Tea Quasterly **42**, 40–47 (1971).
2 Fernando, V. and Bhavanandan, V. P., Tea Quarterly **42**, 48–56 (1971).
3 Volk, G., Agron. J. **51**, 746–749 (1959).
4 Watson, G. A., Chin, Tettsoy and Wong, Phui Weng, J., Rubb. Research Inst. Malaya **16**, 77–90 (1962).