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NITROGEN LOST BY AMMONIA VOLATILISATION, AND THE EFFECTIVENESS OF UREA AND AMMONIUM SULPHATE FERTILISERS

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When nitrogen fertiliser is applied to soil, some of the N may be lost to the atmosphere in the form of ammonia. Different forms of fertiliser are more or less susceptible to losing N after application, and climatic conditions are known to influence volatilisation rates,

METHODS

Ammonium sulphate and Kapuni urea were applied to a ryegrass-white clover sward at Palmerston North, at 50 and 200kg N/ha in late winter and late autumn. Nitrogen loss by ammonia volatilisation, soil mineral-N levels and pasture response were measured until soil mineral-N levels approached background concentrations (Ball *et al.* 1979). The spring (late winter application) experiment ran from 26 August to 14 December 1981 and the autumn study from 7 April to 19 August 1982.

RESULTS AND DISCUSSION

No significant rain fell until 9 and 22 days after treatment application in the spring and autumn respectively. Initial soil moisture (0-75mm) wasapproximately 5% in excess of field capacity (F.C. = 34% gravimetric moisture) at the time of spring application and 59% of F.C. at the time of autumn application. Soil moisture remained at or near F.C. throughout most of the spring experiment, dropping to 38% F.C. at the end of that study. In autumn, soil moisture had dropped to 46% F.C. on conclusion of the volatilisation phase (15 days) and had increased to near F.C. at the end of the experiment.

Herbage was harvested 35, 65 and 110 days after the spring treatment and 104 and 134 days after autumn application,

Nitrogen losses by ammonia volatilisation from urea, were similar to those previously reported from urine in spring at this site (Ball et *al.* 1979). Nitrogen loss from plots by ammonia volatilisation are presented in Table 1.

Table 1: AMMONIA VOLATILISATION AS A PERCENTAGE OF N APPLIED TO THE MIXED SWARDS (AS = AMMONIUM SULPHATE)

	AS 50	Urea 50	AS 200	Urea 200
Spring	<0.5	5	<0.5	16
Autumn	8	42	10	86

This shows that significant amounts of N can be lost from urea, especially under drier conditions. Losses from ammonium sulphate were always smaller.

At the first herbage harvest in spring, all N treatments produced significantly

more than the control (Table 2). Ammonium sulphate, applied at 200kg N/ha, was the only treatment with a strong residual herbage response. The use of 50kg N/ha gave no residual response in spring although ammonium sulphate 50 produced 25% more dry matter (DM) than control in the second autumn harvest. In the autumn experiment, ammonium sulphate was superior to urea at both N rates in both harvests. In spring urea suppressed herbage clover yield to a lesser extent than ammonium sulphate. Ball and Field (1982) reported a similar result.

Table 2: HERBAGE DRY MATTER YIELD (Kg DM/ha) FOR THE TWO EXPERIMENTS (AS = AMMONIUM SULPHATE)

	Control	AS 50	Urea 50	AS 200	Urea 200
			SPRING		
Total	6030	6250	6130	8310	6690
Grass	3680	4880	4550	7570	5760
Clover	1940	1000	1090	250	600
			AUTUMN		
Total	2900	3900	3440	5090	3870
Grass	2350	3510	3050	4780	3550
Clover	460	340	270	210	250

Apparent N recovery in herbage was greater from the ammonium sulphate than urea treatments in both experiments, this difference being significant at the higher N rate. Nitrogen efficiency (kg DM gained/kg N applied) was 7.89 and 2.59 in the spring experiment and 15.43 and 7.82 in autumn for ammonium sulphate and urea respectively. Differences in N efficiency (kg DM gain/kg N applied) and cost efficiency (cents/kg DM gain) between the two N forms, particularly at the higher application rate in autumn do not appear to be as great as the ammonia volatilisation data might suggest.

To calculate cost efficiency (Table 3) the following data were used:- Urea costs $420/t and ammonium sulphate $300/t; transport and spreading costs $28/t, urea 46% N, ammonium sulphate 21% N (i.e. $1.56 and $0.97/kg for ammonium sulphate and urea respectively).

Table 3: COST EFFICIENCY (cents/kg DM gain) OF THE FERTILISERS USED IN THESE EXPERIMENTS.

	AS 50	Urea 50	AS 200	Urea 200
Spring	35	51	14	30
Autumn	8	9	14	20

The use of the 200kg N/ha rate in both fertilisers was more efficient than the 50kg N/ha rate in spring while, in autumn this was reversed with the 50kg N/ha rate being more efficient. The general increase in efficiency of the treatments in the autumn experiment is a reflection of the different growth conditions during

the two experimental periods. At the third harvest during spring control yielded approximately 20% more than both of the N 50 treatments and 40% more than the urea 200. This difference is totally accounted for by treatment effects on clover yield. At this harvest, although the clover content of the ammonium sulphate 200 was the lowest of all the treatments, the grass component was sufficiently large to give a total yield similar to that from control. In autumn clover yields were low, primarily because of initially low soil moisture and later, low soil temperatures. Thus, clover suppression by the fertiliser treatments was masked by climate.

These results indicate that under favourable late winter – early spring conditions, there may be benefits from higher application rates of fertiliser N than are at present recommended. However as the experimental area had been under cutting management for several years prior to these studies, large responses to fertiliser N application would have been expected.

Total soil N measured at the start and end of each experiment indicates that in the autumn experiment, soil N reserves were depleted by 220kg N/ha in the urea 200 treatment compared to 68kg N/ha in the ammonium sulphate 200 treatment. In the urea 200 treatment, this is equivalent to 10% of the total soil N to 30cm. This would explain why, in autumn, the urea 200 treatment, despite a massive volatilised loss of fertiliser N, managed to show a yield increase of almost 5kg DM/$ spent.

Greater loss of N as ammonia from urea than ammonium sulphate is reflected in lower herbage response, particularly at the.higher N application rate, in both experiments. Ammonium sulphate was more cost effective than urea at the 200kg N application rate. At the 50kg N rate in autumn, the higher herbage yield in the ammonium sulphate treatment was offset by the difference between the N forms in fertiliser cost.

REFERENCES

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