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76/R/G/1 and 76/W/G/1 Aqueous Ammonia and Nitrification Inhibitors - Grass

Rothamsted Research

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76/R/G/1 and 76/W/G/1

GRASS

AQUEOUS AMMONIA AND NITRIFICATION INHIBITORS

Object: To study the effects of adding a range of nitrification inhibitors to aqueous ammonia on the yield and nitrogen uptake of grass cut for-silage. Rothamsted (R) Bones Close and Woburn (W) Lower Field.

Sponsors: J. Ashworth, G.G. Briggs, A. Penny.

Design: 2 randomised blocks of 24 plots.

Whole plot dimensions: 2.43 x 9.14.

Treatments: All combinations of:-

1. NI INHIB Nitrification inhibitors added to aqueous ammonia applied at 375 kg N, as a single application, injection tines spaced 30 cm apart:

| | |
|----------|------------------------|
| CS2 | Carbon disulphide |
| NITRAPYR | Nitrapyrin ('N-Serve') |

2. NI RATE Rates of nitrification inhibitors:

| | |
|---|---|
| 1 | 1 (5 kg (R), 2 kg (W) carbon disulphide; 0.5 kg (R) and (W) nitrapyrin) |
| 2 | 2 (12.5 kg (R), 7 kg (W) carbon disulphide; 1.25 kg (R) and (W) nitrapyrin) |
| 3 | 3 (25 kg (R), 20 kg (W) carbon disulphide; 2.5 kg (R) and (W) nitrapyrin) |

3. NI TIME Times of applying aqueous ammonia and nitrification inhibitors:

| | |
|--------|--------|
| AUTUMN | Autumn |
| SPRING | Spring |

plus twelve extra treatments:

EXTRA Aqueous ammonia applied as above:-

| | |
|----------|--|
| AQ/A | Alone, in autumn |
| AQ/S | Alone, in spring |
| AQ+CN1/A | With a mixture of carbon disulphide (12.5 kg (R) and (W)) and nitrapyrin (0.5 kg (R) and (W)) in autumn |
| AQ+CN2/A | With a mixture of carbon disulphide (12.5 kg (R) and (W)) and nitrapyrin (1.25 kg (R) and (W)) in autumn |
| AQ+AT1/S | With ammonium trithiocarbonate (4 kg (R) and (W)) in spring |
| AQ+AT2/S | With ammonium trithiocarbonate (10 kg (R) and (W)) in spring |
| AQ+AT3/S | With ammonium trithiocarbonate (20 kg (R) and (W)) in spring |
| AQ+ST/A | With sodium trithiocarbonate (25 kg (R) and (W)) in autumn |

'Nitro-Chalk', dressing divided between cuts (kg N, total):-

| | |
|--------|------|
| 0 | None |
| NC 250 | 250 |
| NC 375 | 375 |
| NC 500 | 500 |

76/R/G/1 and 76/W/G/1

Basal applications:

Bones Close (R): Manures: (0:14:28) at 500 kg. Weedkiller: Mecoprop at 2.7 kg in 220 l.

Lower Field (W): Manures: (0:14:28) at 500 kg.

Cultivations, etc.:-

Bones Close (R): Aqueous ammonia autumn treatments injected: 14 Nov, 1975.

PK applied: 3 Dec. Aqueous ammonia spring treatments injected:

24 Feb, 1976. 'Nitro-Chalk' applied in three equal applications:

8 Mar, 26 May, 13 Aug. Weedkiller applied: 19 Mar. Cut three times:

24 May, 9 Aug, 26 Oct. Previous crops: Grass since 1952.

Lower Field (W): Aqueous ammonia autumn treatments injected: 17 Nov, 1975.

PK applied: 18 Nov. Aqueous ammonia spring treatments injected:

25 Feb, 1976. 'Nitro-Chalk' applied in three equal applications:

9 Mar, 18 June, 20 Aug. Cut once: 9 June. Previous crops: Permanent grass.

NOTES: (1) Grass samples were taken for N determinations.

(2) N in the injected soil profile was measured at regular intervals from November, 1975 to June, 1976 and ammonia evaporation measured.

76/R/G/1 BONES CLOSE (R)

1ST CUT (24/5/76) DRY MATTER TONNES/HECTARE

***** TABLES OF MEANS *****

| NI RATE | 1 | 2 | 3 | MEAN |
|------------|---------|--------|------|------|
| NI INHIB | | | | |
| CS2 | 5.01 | 5.25 | 5.00 | 5.09 |
| NITRAPYR | 5.07 | 5.22 | 5.18 | 5.15 |
| MEAN | 5.04 | 5.23 | 5.09 | 5.12 |
| NI RATE | 1 | 2 | 3 | MEAN |
| NI TIME | | | | |
| AUTUMN | 5.48 | 5.49 | 5.59 | 5.52 |
| SPRING | 4.60 | 4.98 | 4.59 | 4.72 |
| MEAN | 5.04 | 5.23 | 5.09 | 5.12 |
| NI TIME | AUTUMN | SPRING | MEAN | |
| NI INHIB | | | | |
| CS2 | 5.51 | 4.66 | 5.09 | |
| NITRAPYR | 5.53 | 4.78 | 5.15 | |
| MEAN | 5.52 | 4.72 | 5.12 | |
| NI INHIB | NI RATE | 1 | 2 | 3 |
| CS2 | NI TIME | | | |
| | AUTUMN | 5.68 | 5.36 | 5.49 |
| | SPRING | 4.34 | 5.13 | 4.52 |
| NITRAPYR | AUTUMN | 5.28 | 5.61 | 5.69 |
| | SPRING | 4.86 | 4.82 | 4.67 |
| EXTRA | | | | |
| AQ/A | 5.82 | | | |
| AQ/S | 4.82 | | | |
| AQ+CN1/A | 5.91 | | | |
| AQ+CN2/A | 5.58 | | | |
| AQ+AT1/S | 4.64 | | | |
| AQ+AT2/S | 4.85 | | | |
| AT+AT3/S | 5.29 | | | |
| AQ+ST/A | 5.42 | | | |
| 0 | 2.60 | | | |
| NC 250 | 4.27 | | | |
| NC 375 | 4.63 | | | |
| NC 500 | 5.65 | | | |
| MEAN | 4.96 | | | |
| GRAND MEAN | 5.04 | | | |

***** STANDARD ERRORS OF DIFFERENCES OF MEANS *****

| TABLE | EXTRA | NI INHIB | NI RATE | NI TIME |
|-------|----------|----------|---------|----------|
| SED | 0.348 | 0.142 | 0.174 | 0.142 |
| TABLE | NI INHIB | NI INHIB | NI RATE | NI INHIB |
| | NI RATE | NI TIME | NI TIME | NI RATE |
| | | | | NI TIME |
| SED | 0.246 | 0.201 | 0.246 | 0.348 |

76/R/G/1 BONES CLOSE (R)

2ND CUT (9/8/76) DRY MATTER TONNES/HECTARE

***** TABLES OF MEANS *****

| NI RATE | 1 | 2 | 3 | MEAN |
|----------|------|------|------|------|
| NI INHIB | | | | |
| CS2 | 0.64 | 0.73 | 0.64 | 0.67 |
| NITRAPYR | 0.81 | 0.72 | 0.56 | 0.70 |
| MEAN | 0.73 | 0.73 | 0.60 | 0.68 |

| NI RATE | 1 | 2 | 3 | MEAN |
|---------|------|------|------|------|
| NI TIME | | | | |
| AUTUMN | 0.77 | 0.71 | 0.58 | 0.68 |
| SPRING | 0.69 | 0.75 | 0.62 | 0.69 |
| MEAN | 0.73 | 0.73 | 0.60 | 0.68 |

| NI TIME | AUTUMN | SPRING | MEAN |
|----------|--------|--------|------|
| NI INHIB | | | |
| CS2 | 0.71 | 0.64 | 0.67 |
| NITRAPYR | 0.66 | 0.74 | 0.70 |
| MEAN | 0.68 | 0.69 | 0.68 |

| NI INHIB | NI RATE | 1 | 2 | 3 |
|----------|---------|------|------|------|
| CS2 | AUTUMN | 0.75 | 0.75 | 0.62 |
| | SPRING | 0.54 | 0.72 | 0.66 |
| NITRAPYR | AUTUMN | 0.79 | 0.66 | 0.53 |
| | SPRING | 0.84 | 0.78 | 0.59 |

| | |
|----------|------|
| EXTRA | |
| AQ/A | 0.66 |
| AQ/S | 0.70 |
| AQ+CN1/A | 0.76 |
| AQ+CN2/A | 0.93 |
| AQ+AT1/S | 0.86 |
| AQ+AT2/S | 0.65 |
| AT+AT3/S | 0.93 |
| AQ+ST/A | 0.86 |
| 0 | 0.46 |
| NC 250 | 0.78 |
| NC 375 | 0.67 |
| NC 500 | 0.89 |
| MEAN | 0.76 |

GRAND MEAN 0.72

***** STANDARD ERRORS OF DIFFERENCES OF MEANS *****

| TABLE | EXTRA | NI INHIB | NI RATE | NI TIME |
|-------|-------|----------|---------|---------|
| SED | 0.200 | 0.082 | 0.100 | 0.082 |

| TABLE | NI INHIB | NI INHIB | NI RATE | NI INHIB |
|-------|----------|----------|---------|----------|
| | NI RATE | NI TIME | NI TIME | NI RATE |
| | NI TIME | | | |
| SED | 0.142 | 0.116 | 0.142 | 0.200 |

76/R/G/1 BONES CLOSE (R)

3RD CUT (26/10/76) DRY MATTER TONNES/HECTARE

***** TABLES OF MEANS *****

| | 1 | 2 | 3 | MEAN |
|----------|------|------|------|------|
| NI RATE | | | | |
| NI INHIB | | | | |
| CS2 | 1.34 | 1.44 | 1.26 | 1.34 |
| NITRAPYR | 1.46 | 1.29 | 1.32 | 1.36 |
| MEAN | 1.40 | 1.37 | 1.29 | 1.35 |

| | 1 | 2 | 3 | MEAN |
|---------|------|------|------|------|
| NI RATE | | | | |
| NI TIME | | | | |
| AUTUMN | 1.28 | 1.11 | 1.20 | 1.20 |
| SPRING | 1.52 | 1.62 | 1.37 | 1.50 |
| MEAN | 1.40 | 1.37 | 1.29 | 1.35 |

| | AUTUMN | SPRING | MEAN |
|----------|--------|--------|------|
| NI TIME | | | |
| NI INHIB | | | |
| CS2 | 1.11 | 1.57 | 1.34 |
| NITRAPYR | 1.28 | 1.43 | 1.36 |
| MEAN | 1.20 | 1.50 | 1.35 |

| | NI RATE | 1 | 2 | 3 |
|----------|---------|------|------|------|
| NI INHIB | NI TIME | | | |
| CS2 | AUTUMN | 1.08 | 1.13 | 1.13 |
| | SPRING | 1.60 | 1.75 | 1.38 |
| NITRAPYR | AUTUMN | 1.48 | 1.10 | 1.26 |
| | SPRING | 1.44 | 1.49 | 1.37 |

| | |
|----------|------|
| EXTRA | |
| AQ/A | 1.15 |
| AQ/S | 1.58 |
| AQ+CN1/A | 1.21 |
| AQ+CN2/A | 1.53 |
| AQ+AT1/S | 1.44 |
| AQ+AT2/S | 1.66 |
| AT+AT3/S | 1.78 |
| AQ+ST/A | 1.72 |
| 0 | 0.80 |
| NC 250 | 1.66 |
| NC 375 | 1.76 |
| NC 500 | 1.58 |
| MEAN | 1.49 |

GRAND MEAN 1.42

***** STANDARD ERRORS OF DIFFERENCES OF MEANS *****

| TABLE | EXTRA | NI INHIB | NI RATE | NI TIME |
|-------|-------|----------|---------|---------|
| SED | 0.229 | 0.093 | 0.114 | 0.093 |

| TABLE | NI INHIB NI RATE | NI INHIB NI TIME | NI RATE NI TIME | NI INHIB NI RATE NI TIME |
|-------|---------------------|---------------------|--------------------|--------------------------------|
| SED | 0.162 | 0.132 | 0.162 | 0.229 |

76/R/G/1 BONES CLOSE (R)

TOTAL OF 3 CUTS DRY MATTER TONNES/HECTAHE

***** TABLES OF MEANS *****

| NI RATE | 1 | 2 | 3 | MEAN |
|----------|------|------|------|------|
| NI INHIB | | | | |
| CS2 | 6.99 | 7.42 | 6.90 | 7.10 |
| NITRAPYR | 7.35 | 7.23 | 7.05 | 7.21 |
| MEAN | 7.17 | 7.32 | 6.98 | 7.16 |

| NI RATE | 1 | 2 | 3 | MEAN |
|---------|------|------|------|------|
| NI TIME | | | | |
| AUTUMN | 7.53 | 7.31 | 7.36 | 7.40 |
| SPRING | 6.81 | 7.34 | 6.59 | 6.91 |
| MEAN | 7.17 | 7.32 | 6.98 | 7.16 |

| NI TIME | AUTUMN | SPRING | MEAN |
|----------|--------|--------|------|
| NI INHIB | | | |
| CS2 | 7.33 | 6.87 | 7.10 |
| NITRAPYR | 7.47 | 6.95 | 7.21 |
| MEAN | 7.40 | 6.91 | 7.16 |

| NI INHIB | NI RATE | 1 | 2 | 3 |
|----------|---------|------|------|------|
| CS2 | NI TIME | | | |
| | AUTUMN | 7.51 | 7.24 | 7.25 |
| | SPRING | 6.47 | 7.60 | 6.56 |
| NITRAPYR | AUTUMN | 7.56 | 7.37 | 7.48 |
| | SPRING | 7.14 | 7.09 | 6.62 |

| | |
|------------|------|
| EXTRA | |
| AQ/A | 7.63 |
| AQ/S | 7.11 |
| AQ+CN1/A | 7.87 |
| AQ+CN2/A | 8.03 |
| AQ+AT1/S | 6.94 |
| AQ+AT2/S | 7.16 |
| AT+AT3/S | 7.99 |
| AQ+ST/A | 8.00 |
| 0 | 3.86 |
| NC 250 | 6.72 |
| NC 375 | 7.07 |
| NC 500 | 8.12 |
| MEAN | 7.21 |
| GRAND MEAN | 7.18 |

***** STANDARD ERRORS OF DIFFERENCES OF MEANS *****

| TABLE | EXTRA | NI INHIB | NI RATE | NI TIME |
|-------|----------|----------|---------|----------|
| SED | 0.585 | 0.239 | 0.292 | 0.239 |
| TABLE | NI INHIB | NI INHIB | NI RATE | NI INHIB |
| | NI RATE | NI TIME | NI TIME | NI RATE |
| | | | | NI TIME |
| SED | 0.413 | 0.338 | 0.413 | 0.585 |

76/W/G/1 LOWER FIELD (W)

1ST AND ONLY CUT (9/6/76) DRY MATTER TONNES/HECTARE

***** TABLES OF MEANS *****

| NI RATE | 1 | 2 | 3 | MEAN |
|----------|------|------|------|------|
| NI INHIB | | | | |
| CS2 | 5.11 | 4.96 | 4.24 | 4.77 |
| NITRAPYR | 5.95 | 4.69 | 5.19 | 5.28 |
| MEAN | 5.53 | 4.83 | 4.71 | 5.02 |

| NI RATE | 1 | 2 | 3 | MEAN |
|---------|------|------|------|------|
| NI TIME | | | | |
| AUTUMN | 5.30 | 4.78 | 4.93 | 5.00 |
| SPRING | 5.76 | 4.87 | 4.50 | 5.05 |
| MEAN | 5.53 | 4.83 | 4.71 | 5.02 |

| NI TIME | AUTUMN | SPRING | MEAN |
|----------|--------|--------|------|
| NI INHIB | | | |
| CS2 | 5.00 | 4.54 | 4.77 |
| NITRAPYR | 5.00 | 5.55 | 5.28 |
| MEAN | 5.00 | 5.05 | 5.02 |

| | NI RATE | 1 | 2 | 3 |
|----------|---------|------|------|------|
| NI INHIB | NI TIME | | | |
| CS2 | AUTUMN | 5.13 | 5.25 | 4.62 |
| | SPRING | 5.09 | 4.67 | 3.87 |
| NITRAPYR | AUTUMN | 5.47 | 4.31 | 5.24 |
| | SPRING | 6.43 | 5.08 | 5.13 |

| | |
|----------|------|
| EXTRA | |
| AQ/A | 5.18 |
| AQ/S | 4.67 |
| AQ+CN1/A | 3.49 |
| AQ+CN2/A | 5.17 |
| AQ+AT1/S | 5.55 |
| AQ+AT2/S | 6.24 |
| AT+AT3/S | 3.81 |
| AQ+ST/A | 5.22 |
| 0 | 4.36 |
| NC 250 | 3.45 |
| NC 375 | 4.93 |
| NC 500 | 5.48 |
| MEAN | 4.80 |

GRAND MEAN 4.91

***** STANDARD ERRORS OF DIFFERENCES OF MEANS *****

| TABLE | EXTRA | NI INHIB | NI RATE | NI TIME |
|-------|----------|----------|---------|----------|
| SED | 0.967 | 0.395 | 0.484 | 0.395 |
| TABLE | NI INHIB | NI INHIB | NI RATE | NI INHIB |
| | NI RATE | NI TIME | NI TIME | NI RATE |
| | | | | NI TIME |
| SED | 0.684 | 0.559 | 0.684 | 0.967 |

76/R/G/1 BONES CLOSE (R)

1ST CUT (24/5/76) DRY MATTER TONNES/HECTARE

***** STRATUM STANDARD ERRORS AND COEFFICIENTS OF VARIATION *****

| STRATUM | DF | SE | CV% |
|----------|----|-------|-----|
| BLOCK.WP | 23 | 0.348 | 6.9 |

1ST CUT MEAN DM% 24.5

2ND CUT (9/8/76) DRY MATTER TONNES/HECTARE

***** STRATUM STANDARD ERRORS AND COEFFICIENTS OF VARIATION *****

| STRATUM | DF | SE | CV% |
|----------|----|-------|------|
| BLOCK.WP | 23 | 0.200 | 27.7 |

2ND CUT MEAN DM% 43.2

3RD CUT (26/10/76) DRY MATTER TONNES/HECTARE

***** STRATUM STANDARD ERRORS AND COEFFICIENTS OF VARIATION *****

| STRATUM | DF | SE | CV% |
|----------|----|-------|------|
| BLOCK.WP | 23 | 0.229 | 16.1 |

3RD CUT MEAN DM% 13.5

TOTAL OF 3 CUTS DRY MATTER TONNES/HECTARE

***** STRATUM STANDARD ERRORS AND COEFFICIENTS OF VARIATION *****

| STRATUM | DF | SE | CV% |
|----------|----|-------|-----|
| BLOCK.WP | 23 | 0.585 | 8.1 |

TOTAL OF 3 CUTS MEAN DM% 27.1

PLOT AREA HARVESTED 0.00104

76/W/G/1 LOWER FIELD (W)

1ST AND ONLY CUT (9/6/76) DRY MATTER TONNES/HECTARE

***** STRATUM STANDARD ERRORS AND COEFFICIENTS OF VARIATION *****

| STRATUM | DF | SE | CV% |
|----------|----|-------|------|
| BLOCK.WP | 23 | 0.967 | 19.7 |

MEAN DM% 39.3

PLOT AREA HARVESTED 0.00078