EVALUATION OF DIFFERENT NITROGEN SOURCES ON THE PRODUCTION AND CHEMICAL PROPERTIES OF C_4-SUB-TROPIC PASTURES.

I.F. Reckling*, G.H.J. Krüger

* NWADI, Private Bag X804, Potchefstroom, 2520, Republic of South Africa

ABSTRACT

Digitaria eriantha fertilised with limestone ammonium nitrate (LAN 28 % N), although not statistically significant, resulted in higher dry matter production in comparison to those plants fertilised with urea (U 46% N). Significant lower ($P<0.05$) soil calcium levels were found in plots fertilised with LAN. Plants fertilised with urea had double the amount of Aspartic and Glutamic acid, indicating that urea did not convert to NO_3^-, but was taken up as ammonium.

INTRODUCTION

The response regarding dry matter production of *Digitaria eriantha* to nitrate nitrogen fertilisation proved to be better than its response to ammonium nitrogen (Wolfson & Creswell, 1984). Evaluating the influence of four commercially available nitrogenous fertilisers on the dry matter production of *Digitaria eriantha*, at Nooitgedacht in a moderate climatic zone, Rethman (1987), however, showed that dry matter yields obtained with urea (U 46% N), though not significantly lower, tended to record lower yields compared to LAN and ammonium sulphate (AS 21% N) fertilisation. No data concerning the difference in yields, as influenced by LAN and urea, in the semi-arid region of South Africa, is available. The objective of this study was: (i) to determine whether commercially available nitrogenous fertilisers differed in their effectiveness in a semi-arid environment; (ii) investigate changes in soil properties due to fertilisation and mechanical defoliation and (iii) whether different nitrogenous fertilisers influence plant chemical analyses.

Procedure. The trial was conducted at the North West Agricultural Development Institute at Potchefstroom. The precipitation recorded during the effective growing period was 823 mm in 1993/94, 346 mm in 1994/95 and 1100 mm during the 1995/1996 season. The *Digitaria eriantha* pasture was established in 1985 on a sandy clay Westleigh soil (Macvicar *et al*., 1977) with an effective depth of 500 mm.

Treatments and trial layout. The investigation conducted as a 2 x 4 x 4 simple factorial design. Treatments consisted of two nitrogenous fertilisers, LAN 28 % N and urea (U 46% N). Each was applied at four different levels of 0, 30, 60 and 90 kg N ha^{-1}. A single application was applied in October before the growing season. The same treatment was applied each year to the same locality. After completion of the trial representative soil analyses were carried out for each treatment (Barnard *et al* 1990). After field determination of plant yield, representative samples were dried at 70½C to a constant mass for determination of dry matter content and thereafter all samples were chemically analysed for amino acids as described by Kenneth *et al*. (1977).

Statistical analysis. All data was subjected to comparison by means of the Bonferroni paired t-test (SAS, 1985). The significance of correlations were detected by analysis of variance.

RESULTS AND DISCUSSION

Due to nitrogen fertilisation a decline in soil pH, P, K and Mg was found, over the three year period. No statistical significant differences were found between nitrogen sources or treatments.

Calcium. A statistically significant decline in soil calcium was found as illustrated in Figure 1.

Dry matter production. In agreement with Rethman (1987) no significant difference in dry matter production was found on plots fertilised with LAN or urea. However, plots fertilised with LAN recorded higher dry matter production, consistently over the three year period.

Amino acids. The amino acid concentration of *Digitaria eriantha* above ground dry matter samples are illustrated in Table 1.

DISCUSSION

When NH_4^+ and NO_3^- are supplied in equal concentrations to ryegrass (Clarkson & Warner 1979), NH_4^+ was absorbed more readily than NO_3^- at lower temperatures. Due to the relatively high temperatures experienced at Potchefstroom the absorption of NO_3^- will therefore be enhanced. The tendency of *Digitaria eriantha*, fertilised with LAN, to produce more abundantly may be attributed to the fact that NO_3^- is readily available. If NH_4^+ and NO_3^- are supplied in unequal concentrations plants absorb the nitrogen source which occurs less (Jones, 1985). This implies that LAN is duly benefited because NO_3^- and NH_4^- are supplied in equal amounts while urea is converted to NH_4^+ and then to NO_3^-. According to Mengel & Kirby (1987) urea fertilisation on sunflowers resulted in lower absorption of nitrogen and disturbance of protein metabolism and a pronounced accumulation of aspargine occurred. In the amino acid analysis, plots fertilised with 90 kg N ha^{-1} urea had double the amount of glutamine, aspartic acid and proline in comparison to plots fertilised with 90 kg N ha^{-1} LAN. The higher concentration of glutamatic acid therefore indicates that NH_4^+ was readily taken up by *Digitaria eriantha* before oxidisation could take place. In agreement with Miles & Manson (1992) the significant ($P<0.05$) decline in Ca^{2+} in all LAN plots can be attributed to leaching of NO_3^- or after nitrification of unused NH_4^+ fertiliser and nutrient export. Together with double the amount of glutamine acid present in *Digitaria eriantha* samples, fertilised with urea, indicates that urea did not convert to NO_3^-.

CONCLUSION

Urea is volatile and therefore the lower yields obtained with urea fertilisation may be due to volatilisation, resulting in less available nitrogen for growth. Furthermore it would thus seem that the conversion of urea to nitrate is not always efficient. The influence of external factors must therefore be quantified, to enable researchers to address this lower efficiency of urea.

REFERENCES

Barnard, R. O., Buys, A. J., Coetsee, J. G. K., Du Preez, C. C., Meyer, J. H., Van Der Merwe, A. J., Van Vuuren, J. A. J. & Volschenk, J. E. 1990. The non-affiliated soil analysis work committee. Handbook of standard soil testing methods for advisory purposes. Soil Sci. Soc. of S.A., P. O. Box 30030, Sunnyside, Pretoria.

Clarkson, D. T. & Warner, A. J. 1979. Relationship between root temperature and the transport of ammonium and nitrate ions by Italian and perennial ryegrass (*Lolium multiflorum* and *Lolium perenne*). Plant Physiol. **64:** 557-561.

Jones, G. A. 1985. C4 grasses and cereals. Growth, development and stress responses. Wiley Int. Pub. New York. pg: 190-331.

Kenneth, R. L., Rice, H. R. & Gehrke, C. W. 1977. Complete mass spectra of N-trifluoroacetyl-*n*-butyl esters of amino acids. *J.Chromatography*. 141: 123-144.

Macvicar, C.N., De Viliers, J.M., Loxton, R.F., Verster, E.,Lambrechts, J.J.N., Merryweather, F.R., Le Roux, J., Van Rooyen, T.H. & Harmse, H.J. Von M. 1977. Soil classification. A binomial system for South Africa. Department of Agricultural Technical Services, Pretoria.

Mengel, K. & Kirby, E. A. 1987. Principles of plant nutrition. Pub. International Potash Inst. Bern, Switzerland. :427-488.

Miles, N. & Manson, A. D. 1992. Considerations on the sustainability and environmental impact of intensive pastures. *J. Grassl. Soc. Sth. Afr.* **9:** 135-140.

Rethman, N. F. G. 1987. The effect of form and level of nitrogen fertilization on the yield of *Digitaria eriantha* Steud. J. *Grassl. Soc. South Afr.* 4, (3): 105-108.

SAS, 1985. Statistical Analysis Systems Users Guide (5th edn.). Institute Inc. Raleigh, North Carolina.

Wolfson, Maureen, M. & Cresswell, C.F. 1984. The effect of nitrogen on the development and photosynthetic activity of *Digitaria eriantha* Steud. subsp. eriantha. *J. Grassl. Soc. Sth. Afr.*,**1:** 33-36.

Table 1
Amino acid concentration (µg 100 mg^{-1}, dryweight), obtained under natural conditions and fertilised with 0 and 90 kg N ha^{-1} of the source LAN and urea, after completion of trial (1993-1996) at Potchefstroom.

	0 kg N/ha	90 kg N/ha Urea	90 kg N/ha LAN
Crude protein	11.5	14	14
Threonine	38.6	6.427	44.22
Valine			20.9
Methionine	4.882	12.53	5.23
Isoleucine			13.33
Leucine	28.67	75.67	
Phenyl-alanine	17.71	-	16.46
Glycine		6.332	3.118
Glutamic	43.35	88.25	48.49
Aspartic	12.95	54.94	20.42
Alanine	7.43	39.8	21.14
Proline	57.48	140.48	69.52

Figure 1
The influence of LAN and urea fertilisation as well as defoliation on residual soil calcium levels at Potchefstroom, over a three year period (1993-1996), on a sandy clay Westleigh soil.