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THE NITROGEN FERTILIZER VALUE OF MINERAL CONCENTRATES ON GRASSLAND IN FIELD EXPERIMENTS

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In the Netherlands initiatives are taken to process animal manure as a method to increase mineral efficiency and to export the phosphorus surplus in animal manure (Velthof et al., 2012). A possibility is separating manure by ultrafiltration or comparable techniques into a thin fraction with mainly mineral nitrogen (N) and potassium (K) for domestic use and a thick fraction with mainly organic N and phosphorus (P) for export. The thin fraction is further concentrated by reversed osmosis into mineral concentrate (MC). For an efficient use of MC it is necessary to know the N fertilizer replacement value (NFRV). In normal slurry the NFRV is mainly determined by ammonia-N (NH_4-N), only a small fraction of the organic N is as effective as mineral fertilizer in the year of application. In MC about 90 % of the N is NH_4-N. Thus we expected that MC would have an NFRV that is only slightly lower than 90 % of a reference mineral fertilizer because of ammonia volatilization. However, MC's were not tested in field experiments before. Therefore grassland field experiments took place from 2009 to 2012 to determine the NFRV of MC of different producers.

In the grassland experiments the N uptake of grass by applying MC of pig slurry was compared with the N uptake by applying calcium ammonium nitrate (CAN) and liquid ammonium nitrate (LAN). The experiments contained four application rates for all fertilizers: 0, 100, 200 and 300 kg N per ha, divided over three successive cuts. MC and LAN were injected approximately 5 cm into the soil, CAN was broadcasted with a machine for experimental fields. On the 0 N plots, the application machines were used without fertilizer. In 2009 and 2010 CAN, LAN and MC from three producers were applied in one, two or three successive cuts and in 2011 and 2012 CAN, LAN and MC from one producer in three successive cuts. In 2009 and 2010 the soil types were clay and sand, in 2011 sand and in 2012 relatively wet sand and sand with normal hydrological circumstances (for the Netherlands). On all plots dry matter (DM) yield and N content of the grass were measured in five cuts. After the growing season, mineral N in the soil in 0-30 cm was measured to estimate the potential N leaching. In the 2012, nitrate-N in the first 100 cm of groundwater was measured to estimate actual N leaching.

The data of annual DM yield and N yield, calculated by Σ(DM yield per cut x N content per cut), were statistically analysed with the Residual Maximum Likelihood method (Reml; Harville, 1977). In Reml a linear fixed and a random model are defined. The fixed model was defined with type of fertilizer, year, soil type, N level, N level^2, number of fertilized cuts and the interactions. Non-significant terms and interactions were deleted. The random model was defined with the interaction location.block.plot.

With the developed statistical model for N yield the NFRV was calculated by dividing the Apparent N Recovery (ANR) of MC by the ANR of the reference (CAN). ANR was calculated as (N yield at N-fertilization minus N yield at zero N-fertilization) divided by N-fertilization.

Mineral N in the soil and nitrate N in groundwater was statistically analysed with ANOVA.

Results

The responses of DM and N yield to N-fertilization was (as expected) positive for all fertilizers. However it showed a large variance between years, including responses to the reference fertilizers CAN and LAN. The responses to MC and LAN were lower than expected compared to the response to CAN. This resulted in NFRV's for MC that varied between 54% and 81%, with CAN as a reference fertilizer. In case of LAN as reference fertilizer, the NFRC's for MC varied between 83% and 102%.

Table 1: Nitrogen Fertiliser Replacement Value (%, compared to CAN and liquid ammonium nitrate LAN) of mineral concentrate (MC) in various experiments on grassland. Results of 2009-2012.

		Reference fertilizer: CAN			Reference fertilizer: LAN		
Soil type	Year	CAN	LAN	MC	CAN	LAN	MC
Clay+sand	2009	100	63	54	159	100	86
Clay+sand	2010	100	69	71	144	100	102
Sand	2011	100	102	80	98	100	79
Sand	2012	100	98	81	103	100	83

It is not clear why the response of DM and N yield are lower to liquid fertilizers (LAN and MC) than to CAN in some years. The application method caused only minor damage in the first cut and the growth was compensated in next cuts. A possible explanation for the lower yields on the LAN plots compared to CAN could be that grassland responses to liquid N fertilizers are often lower than to CAN (De Boer, 2010). The cause or mechanism of this difference is not known. The NFRV of MC was in general lower than of LAN. This difference might be explained by ammonia volatilization as MC has a high ammonia concentration and pH (ca. 8). The mineral N in soil and nitrate N in groundwater under MC and LAN, however, was not significantly different from those under CAN. It was not likely that the non-recovered N caused higher leaching. Possibly it was lost through gaseous N emissions and/or stored as organic N in the soil.

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