

Effect of fertilizer application rate on nitrate leaching in Denmark

Promilleafgiftsfonden for landbrug



STØTTET AF

LOCATION OF THE TRIALS





AIM

Investigate leaching from Danish agriculture in practice and investigate how leaching depends on the level and type of nitrogen application.

BACKGROUND

Total leaching of nitrogen from fertilizers depends on several factors including nitrogen application rates. It has been discussed how much nitrate leaching in Danish agriculture can be reduced by a reduction in nitrogen application rates. Therefore, SEGES investigated the effect of increasing levels of nitrogen application on nitrate leaching and calculated the marginal leaching from different crops and soil types.

METHODS

In total, 29 trials in five different locations around Denmark were completed from 2015-2021. The trials were complete randomized block designs. All trials included different levels of added nitrogen and were designed so the same plots received the same levels of nitrogen each year. Although, the level was to some extend adjusted according to the main crop. Leaching was measured with suction cups in one meter depth. The crops were mainly winter cereals, but also included maize, sugar beet and oilseed rape. In one of the trials there was besides the plots with mineral fertilizer plots with addition of pig slurry.

TABLE. KEY RESULTS FROM THE 29 TRIALS INVESTIGATING LEACHING IN DANISH AGRICULTURE. THE TRIALS WERE DONE IN THE

YEARS 2015-2021

			· · · · · · · · · · · · · · · · · · ·							MARGINAL
					PERCO-			OPTIMAL	LEACHING AT	LEACHING AT
	HARVEST	MEASURE		RAIN FALL,	LATION,		WINTER	NITROGEN	OPTIMAL RATE	OPTIMAL RATE,
	YEAR	YEAR	SOIL TYPE	MM	MM	CROP	COVERAGE	RATE	KG N PER HA	PCT.
Sandy soil. 13 trials										
Holstebro	2015	2015/2016	JB1	1341	834	Winter wheat	Wintercrop		102	19,5
Holstebro	2016	2016/2017	JB1	995	564	Winter wheat	Winter cereal	206	43	17
Holstebro	2017	2017/2018	JB1	1162	701	Triticale	Winter cereal	191	63	34
Holstebro	2018	2018/2019	JB1	1139	784	Winter rye	Winter cereal	171	67	42
Holstebro	2019	2019/2020	JB1	1579	1144	Winter rye	Winter cereal	171	55	24
Holstebro	2020	2020/2021	JB1	1217	679	Winter rye	Winter cereal	171	46	28
Holstebro	2021	2021/2022	JB1	1281	892	Winter rye	Winter cereal	171	83	25
Løgumkloster	2016	2016/2017	JB1	970	475	Maize	Bare soil	188	100	37
Jyderup	2017	2017/2018	JB4	832	355	Winter rye	Winter cereal	156	60	22
Jyderup	2018	2018/2019	JB4	608	246	Winter rye	Winter cereal	156	44	63
Jyderup	2019	2019/2020	JB4	855	358	Spring barley	Winter cereal	137	46	11
Jyderup	2020	2020/2021	JB4	638	218	Oil seed rape	Winter cereal	208	84	25
Jyderup	2021	2021/2022	JB4	756	399	Winter wheat	Winter cereal	181	57	23
Average				1025	583				62	29
Clay soil. 16 trials										
Ringsted	2017	2017/2018	JB6	889	349	Winter barley	Oil seed rape	194	50	16
Ringsted	2018	2018/2019	JB6	673	244	Oil seed rape	Winter cereal	215	58	20
Ringsted	2019	2019/2020	JB6	841	318	Winter wheat	Winter cereal	212	71	22
Ringsted	2020	2020/2021	JB6	620	141	Winter wheat	Winter cereal	189	25	21
Ringsted	2021	2021/2022	JB6	743	255	Triticale	Bare soil	187	26	10
Odder	2017	2017/2018	JB6	834	297	Winter wheat	Oil seed rape	212	30	20
Odder	2019	2019/2020	JB6	1020	532	Winter wheat	Winter cereal	212	34	14
Odder	2020	2020/2021	JB6	698	203	Winter wheat	Winter cereal	209	16	11
Odder	2021	2021/2022	JB6	877	382	Winter wheat	Winter cereal	209	94	70
Guldborg	2015	2015/2016	JB7	864	383	Winter wheat	Weeds		29	15
Guldborg	2016	2016/2017	JB7	660	164	Sugar beet	Bare soil	133	9	2
Guldborg	2017	2017/2018	JB7	930	407	Spring barley	Winter cereal	148	34	11
Guldborg	2018	2018/2019	JB7	641	184	Winter wheat	Catch crop	224	19	4
Guldborg	2019	2019/2020	JB7	834	312	Sugar beet	Bare soil	134	33	14
Guldborg	2020	2020/2021	JB7	610	127	Spring barley	Bare soil	147	25	5
Guldborg	2021	2021/2022	JB7	696	236	Spring barley	Bare soil	147	64	12
Average				782	285				37	17



EFFECT OF MINERAL FERTILIZER

The major variation within the trials was caused by the contrast in weather conditions, crop type and nitrogen level. The leaching increased with higher nitrogen levels, but the increase was relatively small up until the optimal nitrogen rate. The marginal leaching at the optimal nitrogen rate was highest on the sandy soils (29%) and lower on the loamy soils (17%). The marginal leaching did not increase over time, which indicates that the long term effect of mineral fertilizer is relatively small.

EFFECT OF MANURE APPLICATION

In a single location between 2017 and 2021 the same amounts of nitrogen were added in plots receiving slurry in combination with mineral fertilizer and plots receiving only mineral fertilizer. The hypothesis was to measure intensified leaching due to an increased amount of organic matter added with the slurry in previous years. The rate of leaching per total added amount of nitrogen was the same for mineral fertilizer as for pig slurry. The results are seen in the figure. It appears that addition of 400 kg total nitrogen with pig slurry did not increase leaching in the two following years. The period may be too short to increase the organic pool significantly and, furthermore, the organic content in the slurry was fairly low (20-30%). Other studies indicate application of manure will increase the leaching in the long term, and for example Rashid et al 2021 indicated using Daisy modelling an increased leaching after 100 years of application with manure.

CONCLUSIONS

- The trials show major variations in leaching depending on soil type, rain fall and type of crop.
- The addition of nitrogen exceeding the need of the crop of either pig slurry or mineral fertilizer caused intensified leaching in the present year but did not increase leaching in the following years; in the period 2015-2022.

REFERENCE

Rashid MA, Bruun S, Styczen ME, Ørum JE, Borgen SK, Thomsen IK, Jensen LS





(2021): Scenario analysis using the Daisy model to assess and mitigate nitrate leaching from complex agro-environmental settings in Denmark, Science of The Total Environment, Volume 816, 2022,151518,ISSN 0048-9697. https://doi.org/10.1016/j.scitotenv.2021.151518





CONTACT Nanna Hellum Kristensen SEGES Innovation P/S Crop & Environment Innovation nhkr@seges.dk +45 2895 0070

SEGES Innovation P/S Agro Food Park 15 DK 8200 Aarhus N

+45 8740 5000 info@seges.dk Ε

W seges.dk

