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THE IMPACT OF CROP ON GHG EMISSIONS FROM CLAY SOILS

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Introduction

Since 1961, the amount of food calories per capita have increased by about a third, while consumption of vegetable oils and meat has doubled. At the same time, the use of inorganic nitrogen fertiliser has grown nearly nine times. Agriculture is a source of three primary GHG: CO_2, CH_4 and N_2O. In order to reduce agricultural GHG emissions, agricultural practices have to promote sustainable land management by helping to prevent soil erosion and creating the potential to increase soil carbon stock. Sustainable soil management includes reducing tillage and introducing legumes in crop rotation.

Resarch Aim

The aim of the study is to identify the impacts of the soil tillage and the cultivated crops on formation of GHG emissions.

Materials and Methods

The study site has 24 experimental fields where two types of soil tillage have been used and four crops where grown (wheat *Triticum aestivum*, rape *Brassica napus*, beans *Vicia faba* and barley *Hordeum vulgare*). Soil humidity, soil temperature and measurements of GHG emissions have been carried out during the plant vegetation period from 2018. to 2020. GHG emissions where measured using Picarro G2508. A total of 460 observations were made. Descriptive statistics, box plots, and the Kruskal-Wallis test have been used for data processing using XLSTAT software.

Results

During the study period, a significant amplitude of GHG emission fluctuations is observed. Table 1 summarises the results of GHG measurements and gives an insight into N_2O, CO_2 and CH_4 statistics. Figure 1 shows the distribution of N_2O emissions depending on the crop. The highest dispersion of N_2O emission is observed from barley-grown soils, but the lowest from the beans. The distribution of CH_4 emissions by crop groups is shown in Figure 2. The largest distribution of CH_4 emissions has been observed from wheat-grown soils, while the smallest for barley. Figure 3 shows the distribution of CO_2 emissions depending on the crop. Large scatter and extreme values of CO_2 emissions have been observed for all crops. The highest average value was observed from the soils where barley was grown - 307.261 kg ha^{-1} day^{-1}, while the lowest average value of CO_2 emissions was observed in the rapeseed fields - 205.796 kg ha^{-1} day^{-1}.

Table 1

Values for GHG emissions descriptive statistics

Statistic	N_2O, g ha^{-1} day^{-1}	CH_4, g ha^{-1} day^{-1}	CO_2, kg ha^{-1} day^{-1}
Nbr. of observations	460	460	460
Nbr. of missing values	0	0	0
Minimum	-19.5	-84.8	-13.0
Maximum	273.4	514.1	1026.7
Range	292.8	598.9	1039.8
Median	0.0	-0.4	23.1
Mean	4.8	37.7	66.6
Variance (n)	456.8	5398.3	10971.2
Standard deviation (n)	21.4	73.5	104.7

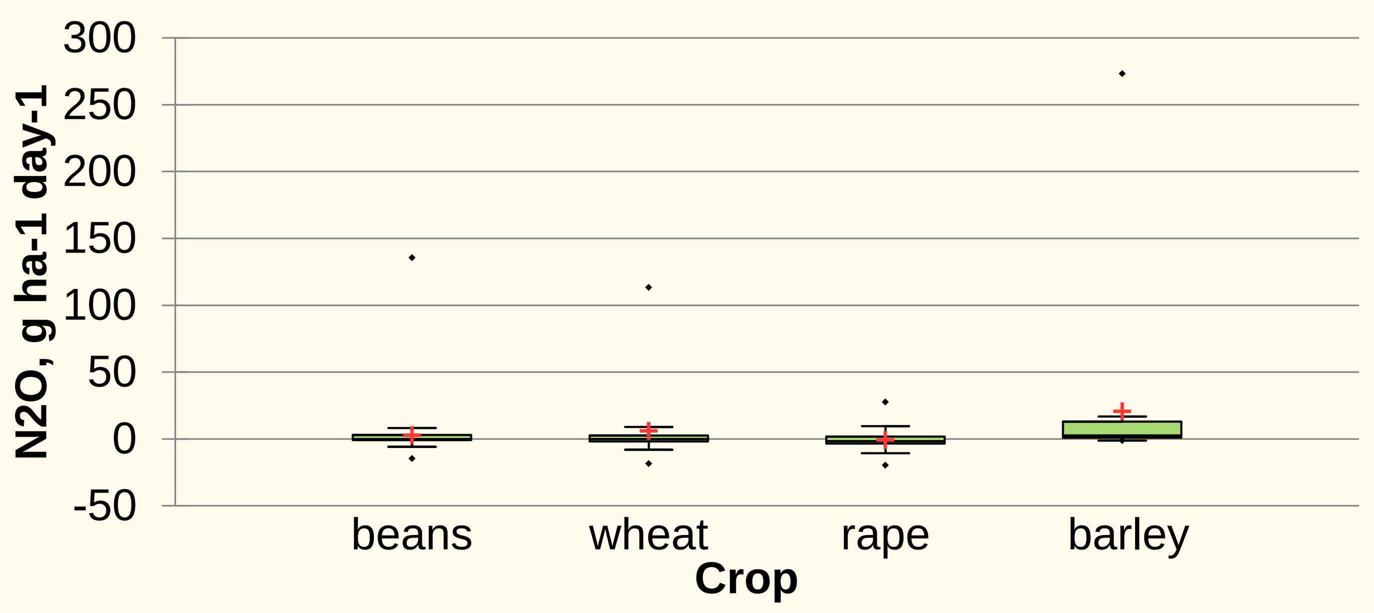

Figure 1. N_2O emissions by crop groups.

Table 2

Multiple pairwise comparisons using the Steel-Dwass-Critchlow-Fligner procedure / Two-tailed test

	N_2O, g ha^{-1} day^{-1}| beans	N_2O, g ha^{-1} day^{-1}| wheat	N_2O, g ha^{-1} day^{-1}| rape	N_2O, g ha^{-1} day^{-1}| barley	Groups		
N_2O, g ha^{-1} day^{-1}| beans		1.336	5.956	-6.942	A		
N_2O, g ha^{-1} day^{-1}| wheat	-1.336		4.766	-6.893		B	
N_2O, g ha^{-1} day^{-1}| rape	-5.956	-4.766		-8.756		B	
N_2O, g ha^{-1} day^{-1}| barley	6.942	6.893	8.756				C

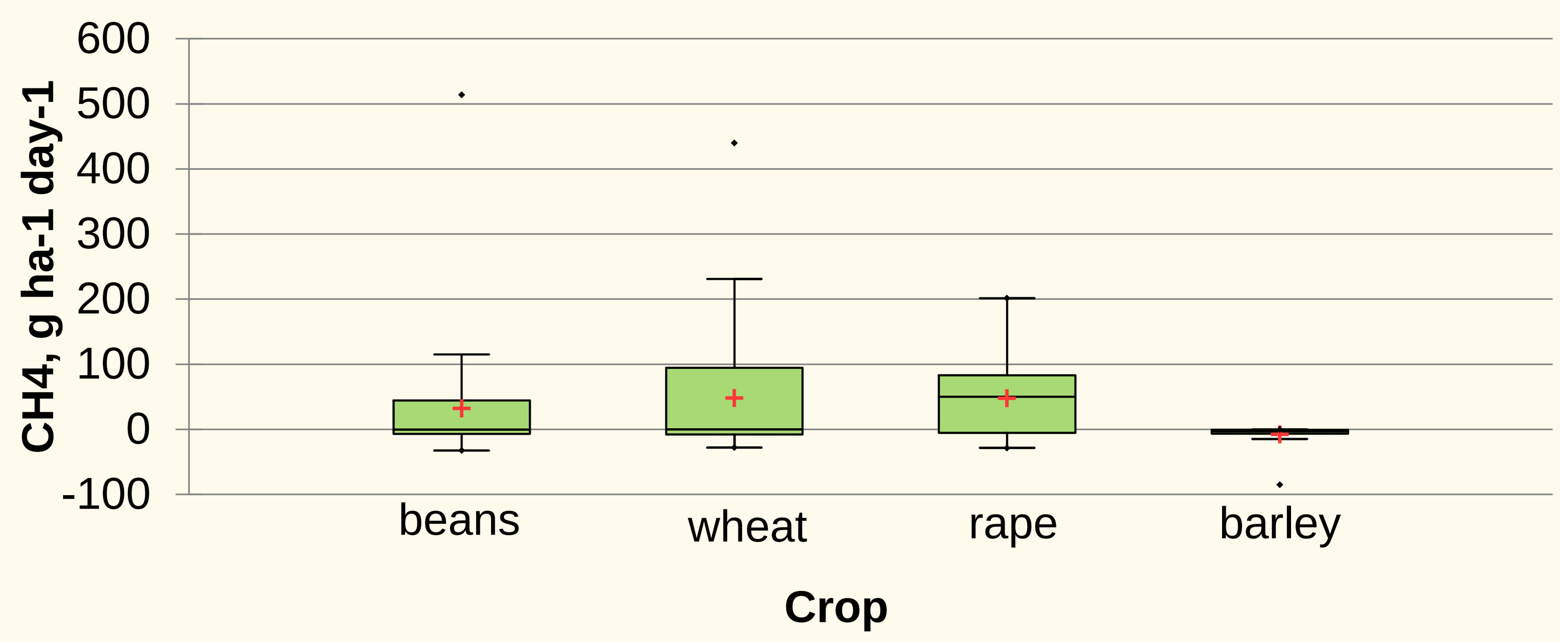

Figure 2. CH_4 emissions of by crop groups.

Table 3

Multiple pairwise comparisons using the Steel-Dwass-Critchlow-Fligner procedure / Two-tailed test

	CH_4, g ha^{-1} day^{-1}| beans	CH_4, g ha^{-1} day^{-1}| wheat	CH_4, g ha^{-1} day^{-1}| rape	CH_4, g ha^{-1} day^{-1}| barley	Groups	
CH_4, g ha^{-1} day^{-1}| beans		-1.375	-3.419	4.580	A	
CH_4, g ha^{-1} day^{-1}| wheat	1.375		-1.262	5.037		B
CH_4, g ha^{-1} day^{-1}| rape	3.419	1.262		6.400		B
CH_4, g ha^{-1} day^{-1}| barley	-4.580	-5.037	-6.400			B

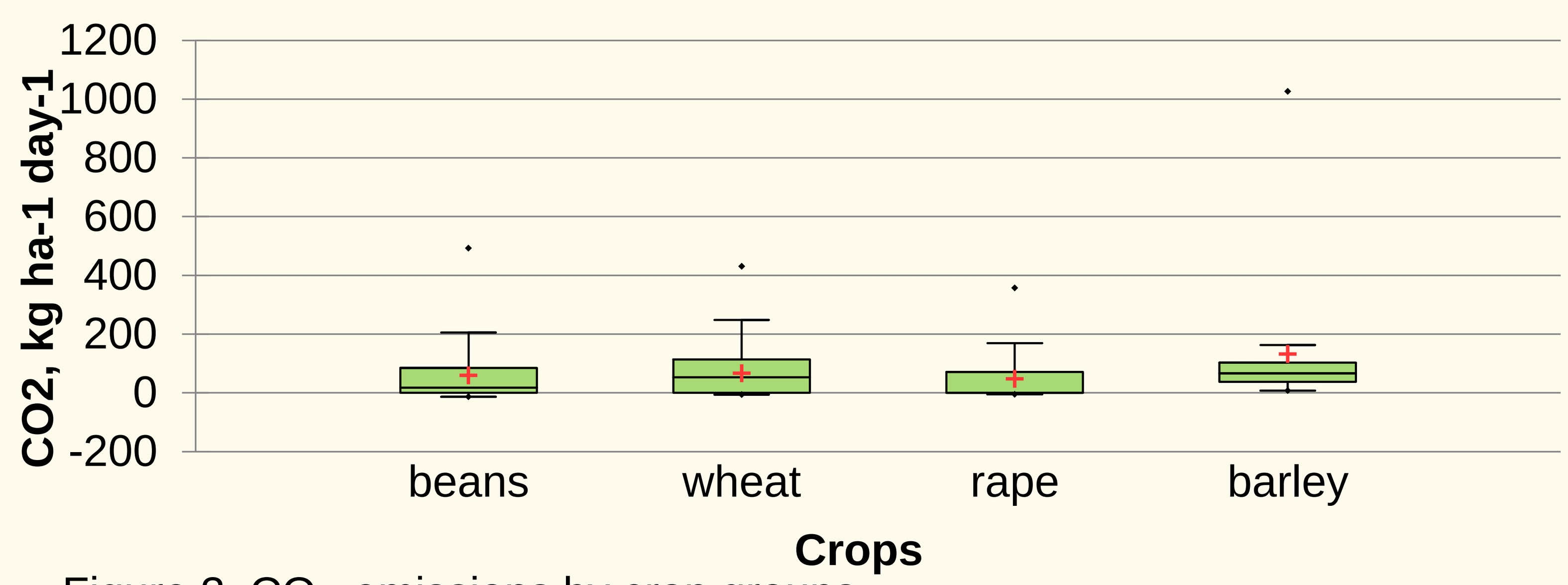

Figure 3. CO_2 emissions by crop groups.

Table 4

Multiple pairwise comparisons using the Steel-Dwass-Critchlow-Fligner procedure / Two-tailed test

	CO_2, kg ha^{-1} day^{-1}| beans	CO_2, kg ha^{-1} day^{-1}| wheat	CO_2, kg ha^{-1} day^{-1}| rape	CO_2, kg ha^{-1} day^{-1}| barley	Groups	
CO_2, kg ha^{-1} day^{-1}| beans		-1.366	1.114	-5.568	A	
CO_2, kg ha^{-1} day^{-1}| wheat	1.366		2.172	-3.517	A	
CO_2, kg ha^{-1} day^{-1}| rape	-1.114	-2.172		-7.162	A	B
CO_2, kg ha^{-1} day^{-1}| barley	5.568	3.517	7.162			B

Conclusions

1. The results of the three-year studies show a significant variability in GHG emissions, especially the extreme values for N_2O emissions.
2. Analysing GHG emissions by crop groups, the Kruskal-Wallis test shows a statistically significant difference in the effect of cultivated crops. Barley has a significant effect on CH_4 emissions compared to other crops.
3. It is necessary to increase the number of plots where measurements are made and the number of measurements by in-depth study of plots where barley is grown. An analysis of the effect of preculture on GHG emissions from clay soils is required.

Contacts

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