Cropping diversification and N fertilization effects on soil greenhouse gas emissions in irrigated Mediterranean conditions

Jorge Álvaro-Fuentes [1*]; Samuel Franco-Luesma [1], Estela Luna [1], Victoria Lafuente [1], Carmen Castañeda [1], Carlos Cantero-Martínez [2], Daniel Plaza-Bonilla [2], José Luis Arrúe [1]

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Context

- Maize monocropping is the main cropping system under irrigated conditions in Spain.

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- Maize monocropping is the main cropping system under irrigated conditions in Spain.
- Typical management includes high N fertilizer rates and irrigation with the concomitant impact on soil greenhouse gas emissions (GHG).
- This study evaluates the impact of alternative diversified cropping systems to maize monocropping and varying N fertilization rates on soil GHG emissions.

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Materials and Methods

EEAD-CSIC Experimental farm
Zaragoza, Spain

Site characteristics	
Rainfall (mm)	344
Air temp (ºC)	14.8
PET (mm)	1100
Soil classification	*Typic Xerofluvent*
Soil texture	Silt loam

First year of a 3-year study
Previous crop: irrigated wheat

1) Cropping system
   - Fallow – maize (monoculture)
   - Pea – maize multiple cropping
   - Barley – maize multiple cropping

2) Mineral N rates in maize
   - 0N: control
   - MN: medium rate
   - HN: High rate

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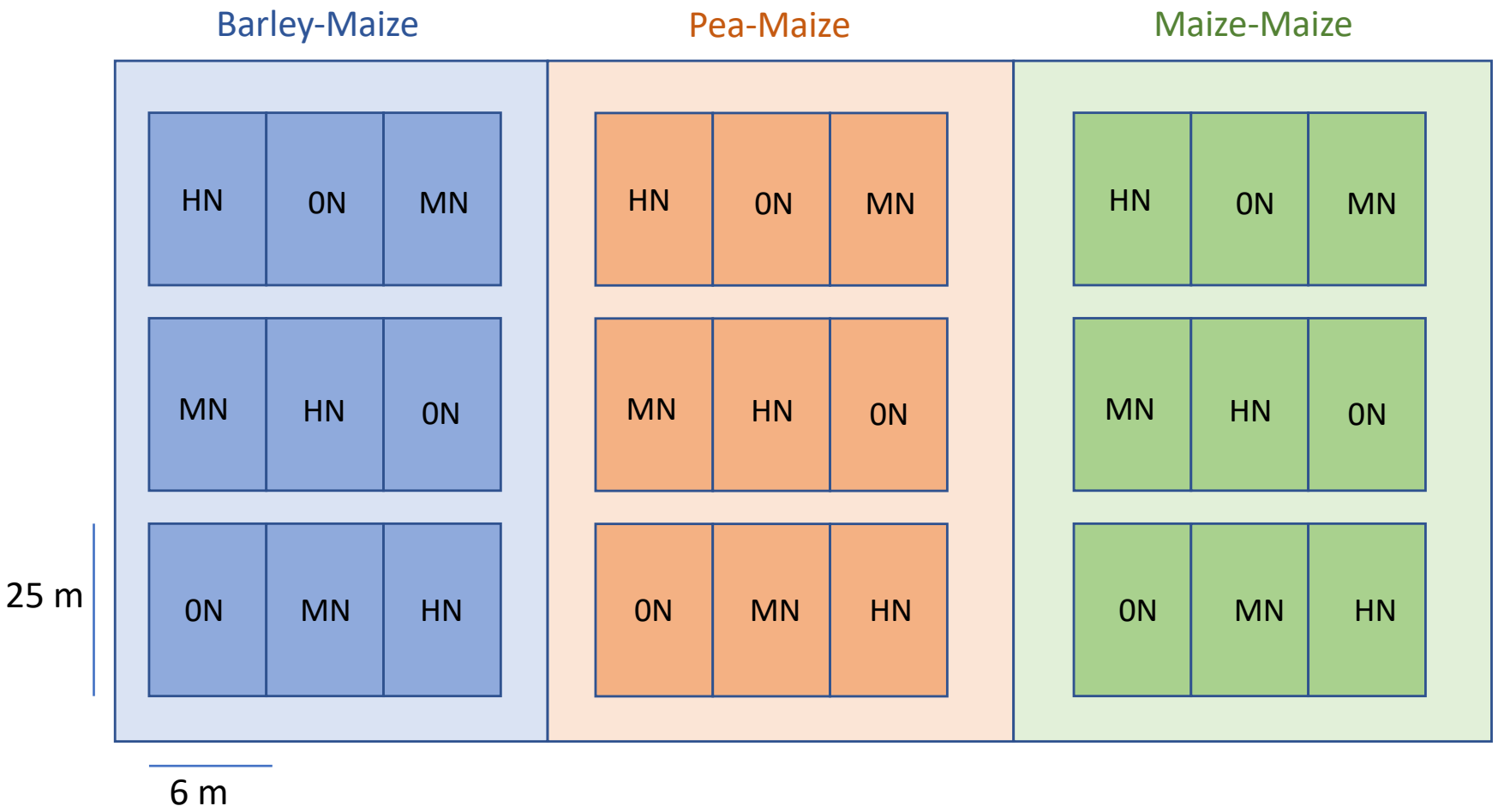

Plot size: 150 m^2

Experimental design: Split-block design

- 0N: control
- MN: medium rate
- HN: High rate

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N fertilizer applied in the maize growing season (kg N ha^{-1})				
	Maize (after fallow)		*Maize (after pea)*	
	Planting (8 April 2019)	Top dressing (17 June 2019)	Planting (17 June 2019)	Top dressing (5 August 2019)
0N	0	0	0	0
MN	50	150	50	100
HN	100	300	100	250

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***Fertilizer**: calcium ammonium nitrate (27% N)*

***Maize cultivars**: - maize after fallow: Pioneer P1921 (FAO 700)*

- maize after pea: Dekalb DKC5032YG (FAO 400)

***Pea harvest**: grain (2682 kg ha^{-1}) + above-ground residue (5689 kg ha^{-1})*

***Irrigation**: Flood irrigation - Pea season (1 irrigation event of 120 mm)*

- Maize after pea (7 irrigation events of 720 mm total)

- Maize after fallow (8 irrigation events of 720 mm total)

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Measurement period: *November 2018 – September 2019*

Measurements: *- Soil GHG emissions (CO_2, N_2O and CH_4)*
- Soil temperature (5 cm)
- Volumetric soil water content (0-5 cm)
(1 measurement per plot)

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- Soil temperature (5 cm)
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(1 measurement per plot)

Sampling frequency: *- Every 2 weeks (pea/fallow phase)*
- Once per week (maize phase)
- Every day (after N applications)

Measurement method: *- Closed chamber (gas sampling)*
- 3 gas samples (0, 20 and 40 minutes)
- Gas sample analysis by gas chromatography

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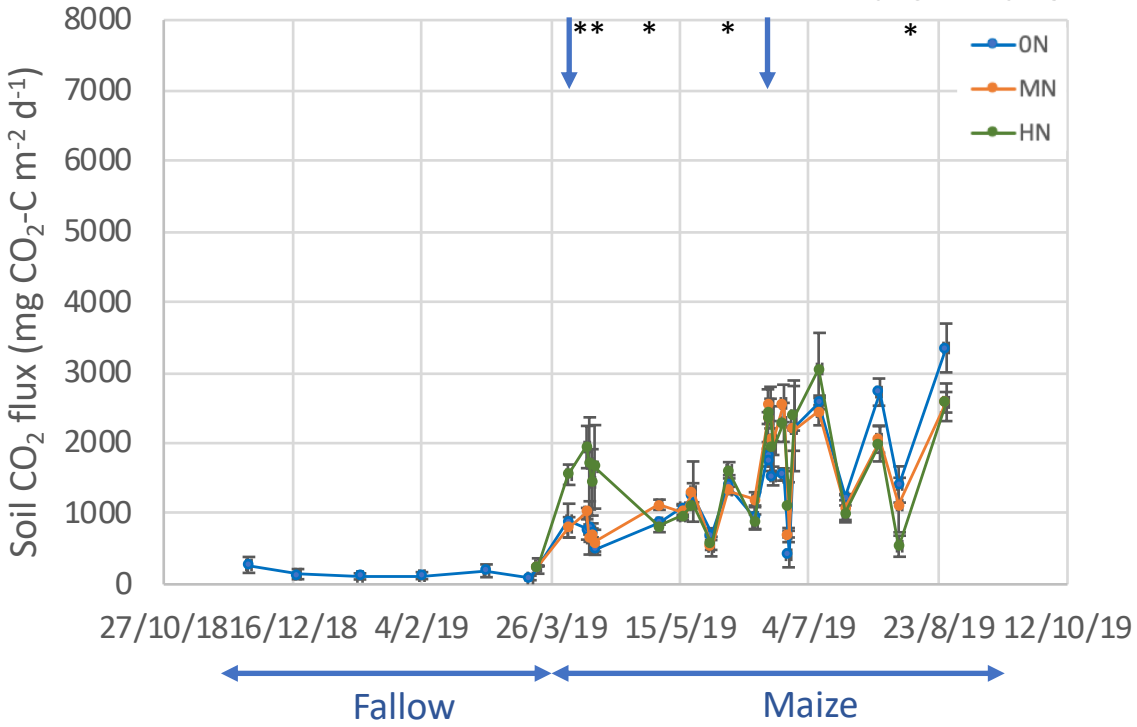
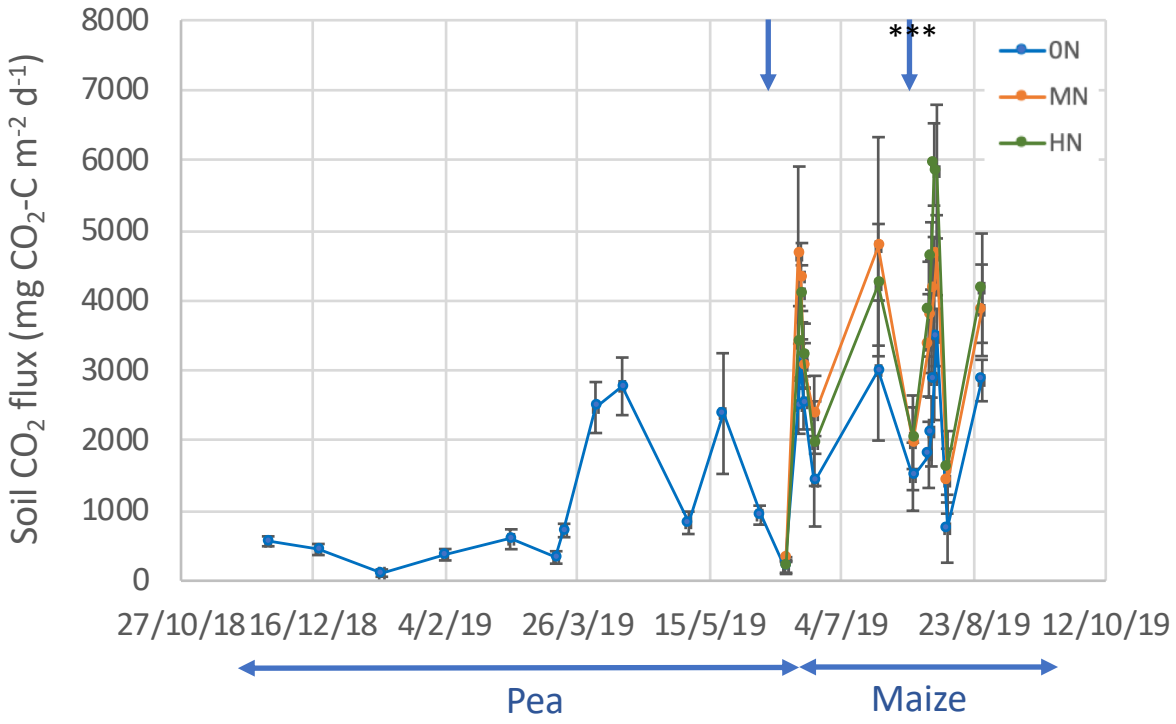
Results

Daily soil CO_2 emissions

Fallow-Maize



Pea-Maize



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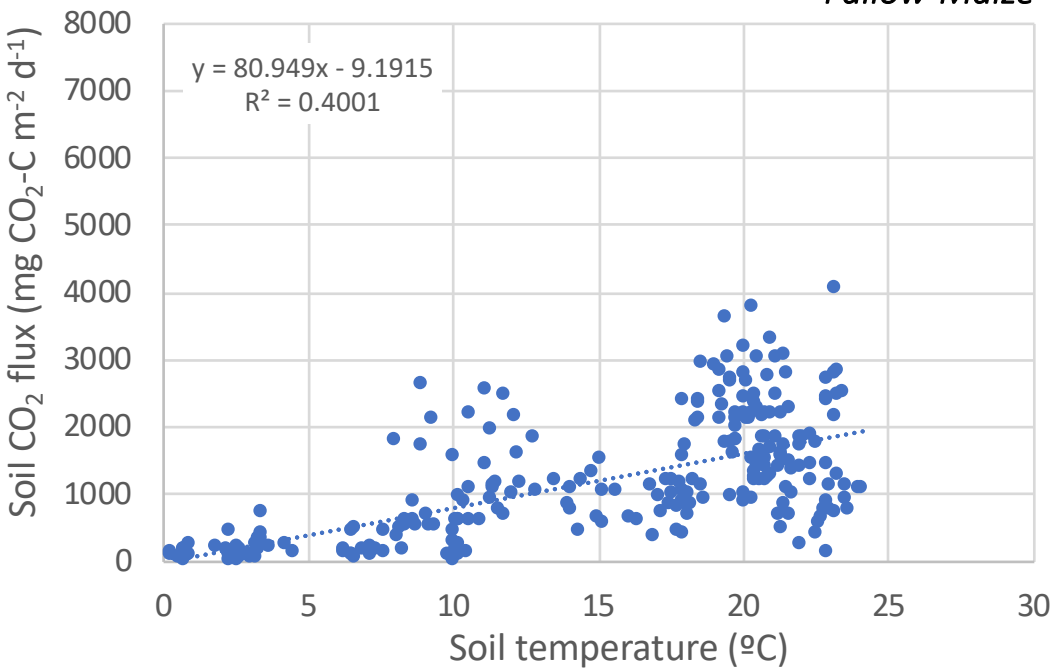
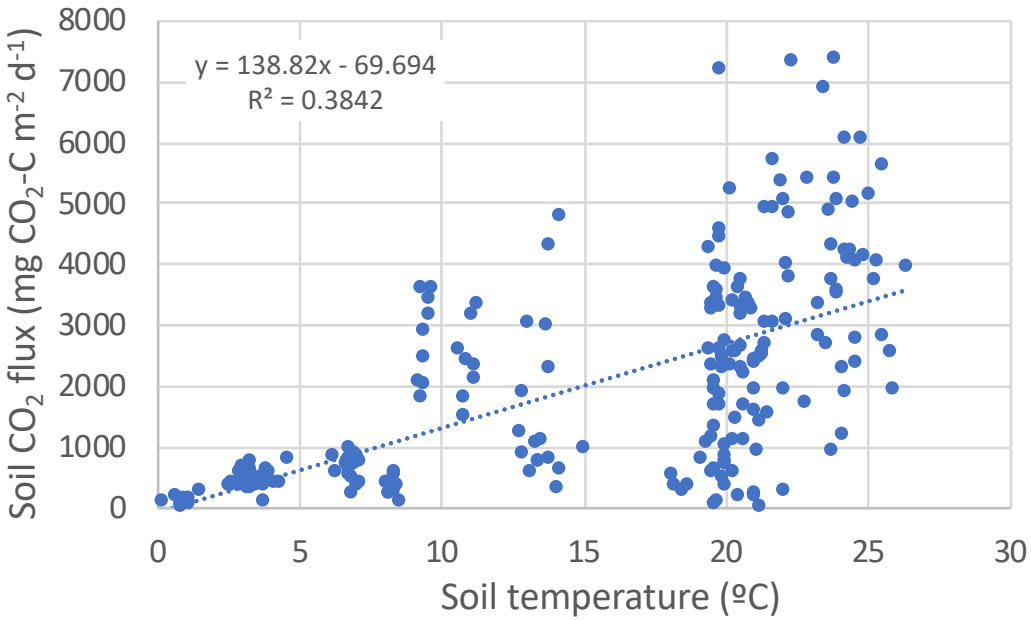
Fallow-Maize



Pea-Maize



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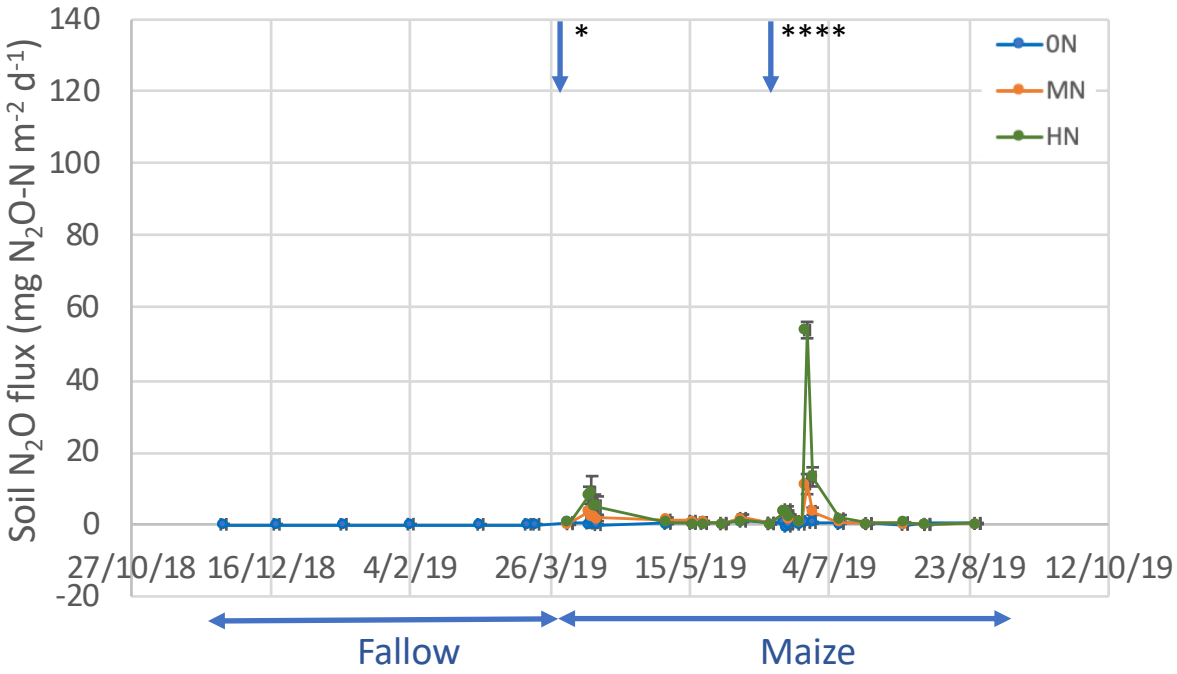
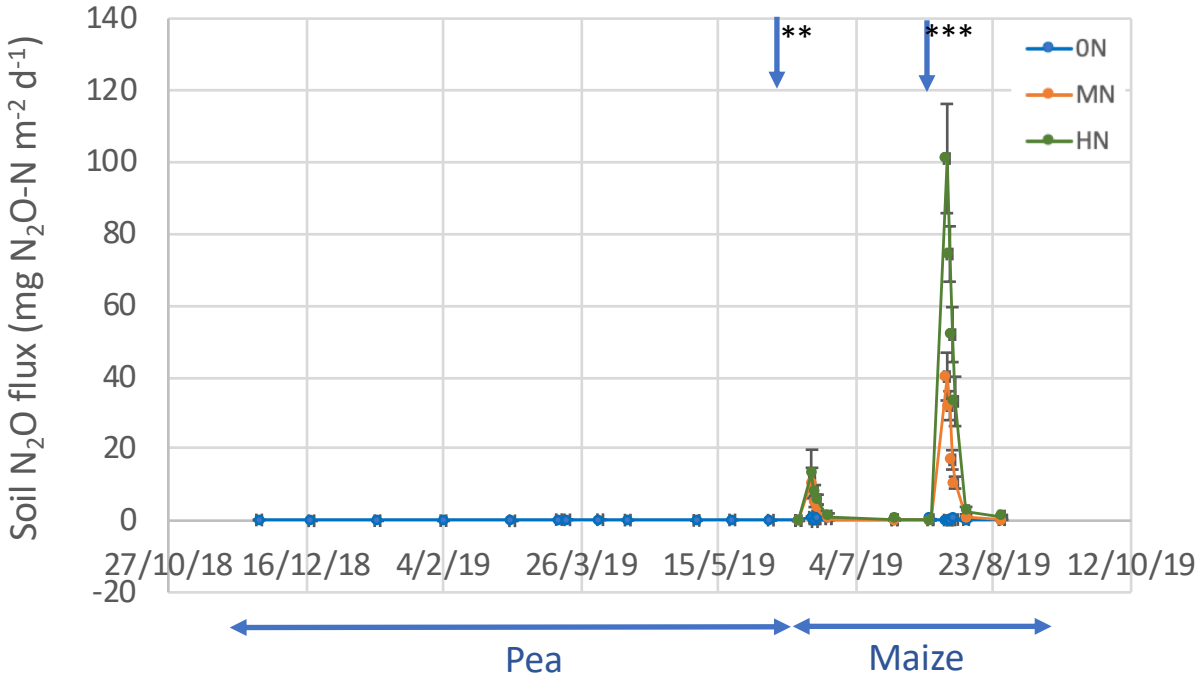
Daily soil N_2O emissions

Fallow-Maize



Pea-Maize



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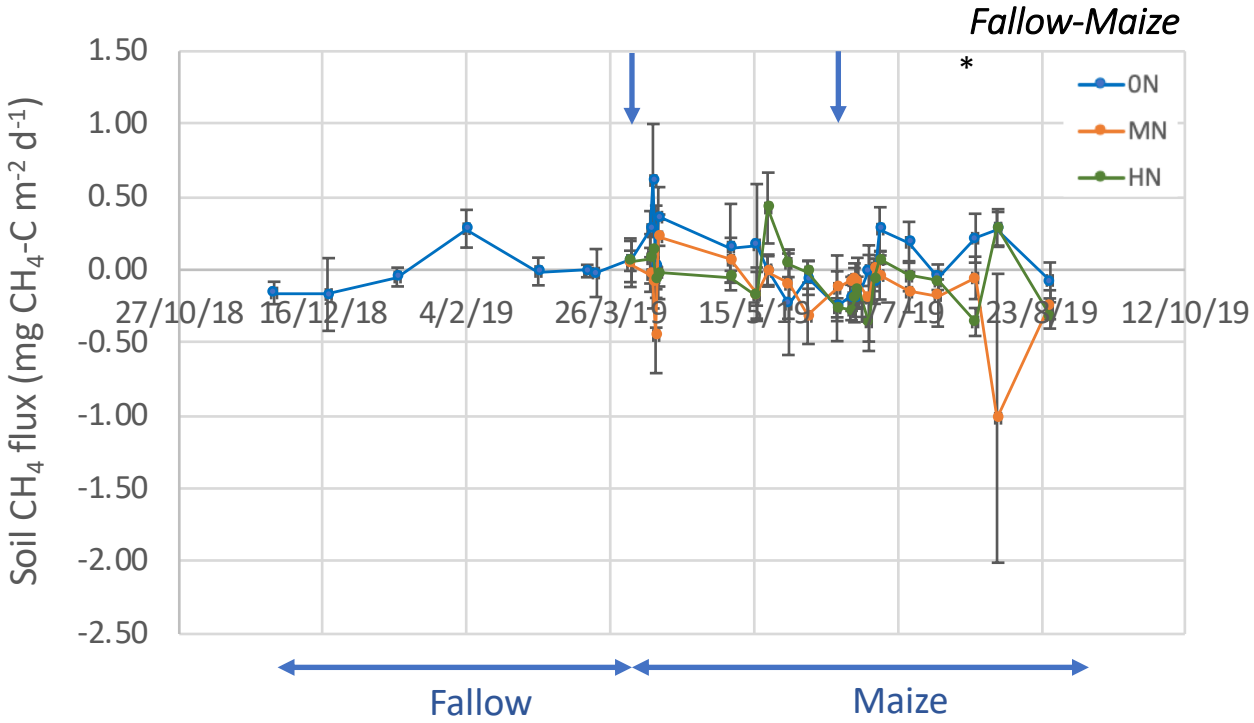
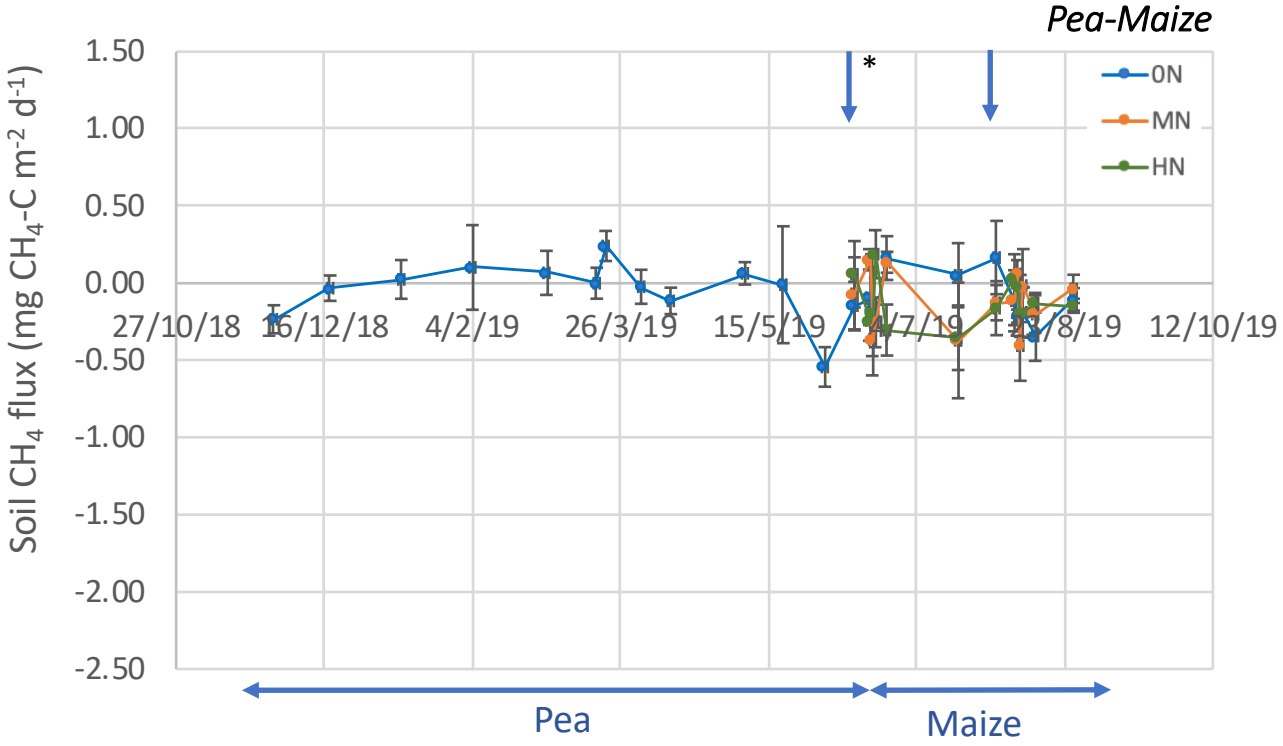
Daily soil CH_4 emissions





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Cumulative emissions during the maize season: ANOVA results (*p-values*)

	CO_2	N_2O	CH_4
Cropping system (Csys)	0.990	<0.001	0.684
N fertilization (Nfer)	0.387	<0.001	0.051
Csys x Nfer	0.155	<0.001	0.053

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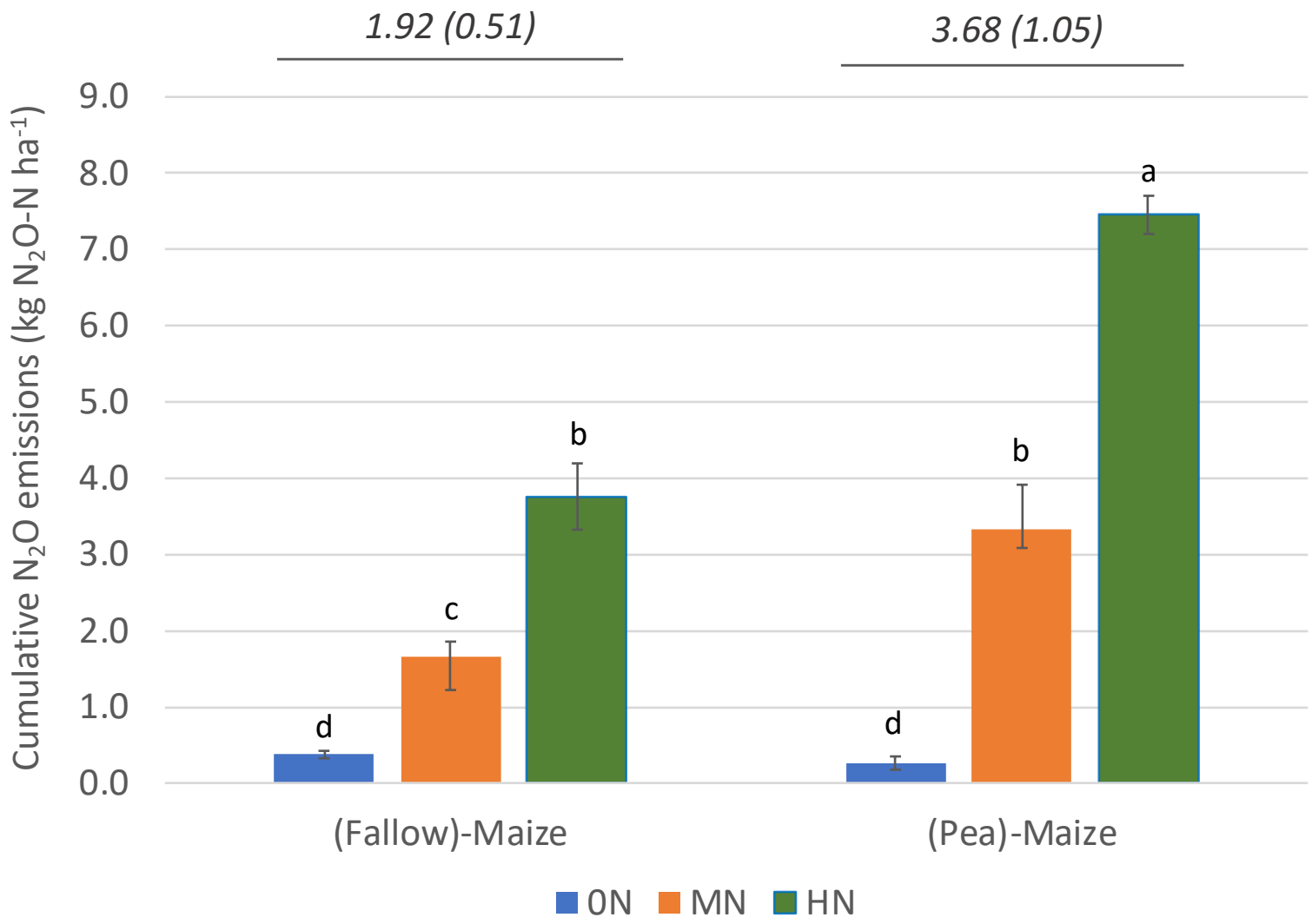

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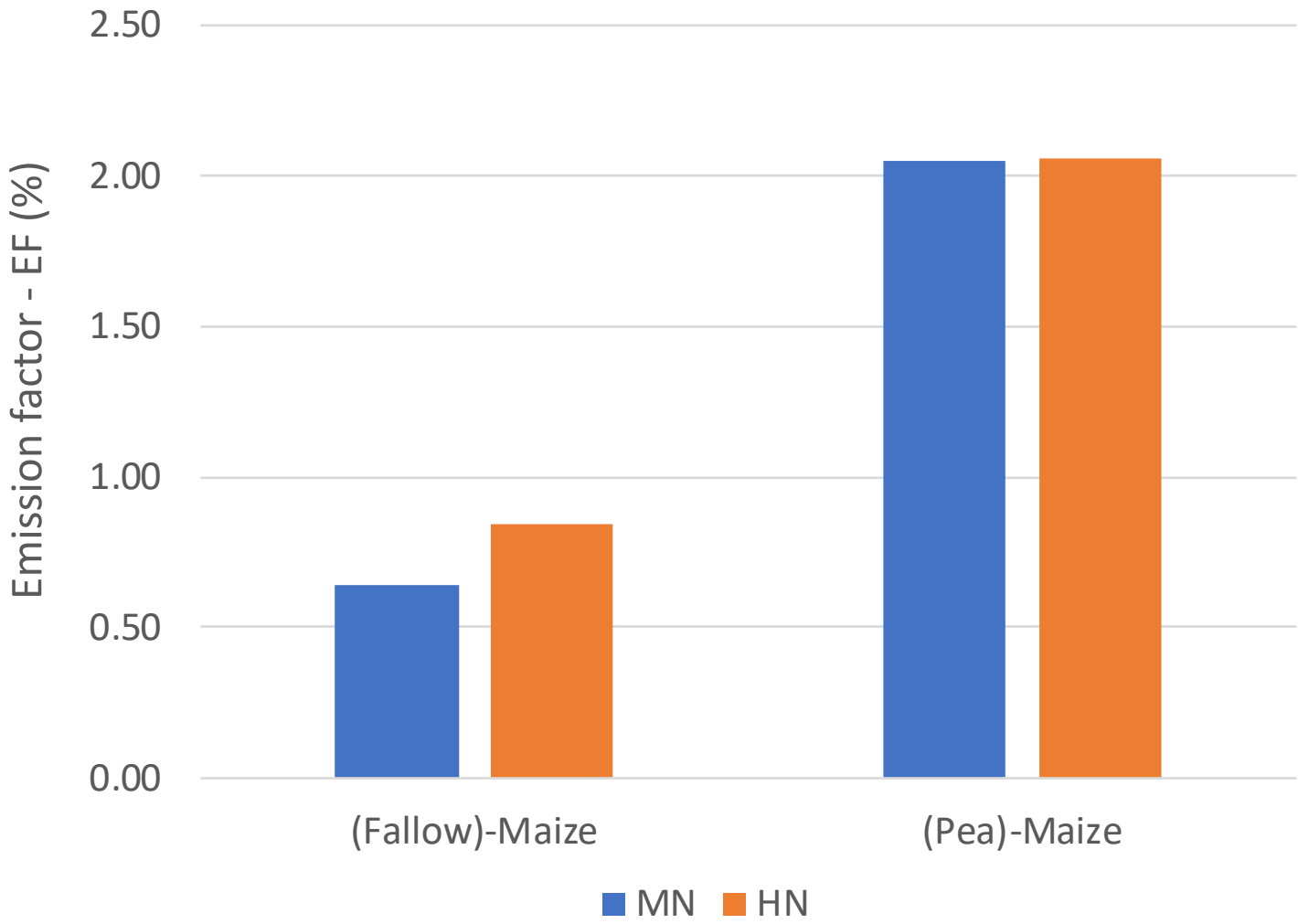

EF= (N_2O emissions $_{fertilized}$) - (N_2O emissions $_{non\text{-}fertilized}$) / (kg N applied)

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Conclusions

- Preliminary results indicate that the shift from a fallow-maize to a pea-maize system only affected maize soil N_2O emissions (no effect observed on neither CO_2 nor CH_4).
- The introduction of a pea phase increased cumulative soil N_2O emissions over the maize season.
- Measurements will continue over next year to corroborate the results found during this first season.

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