soil systems

MDPI

Supplementary Materials for the article

Nitrogen fertilization reduces the capacity of soils to take up atmospheric carbonyl sulphide

Aurore Kaisermann [1]*, Sam P. Jones [1], Steven Wohl [1], Jérôme Ogée[1] and Lisa Wingate [1,]*

[1] INRA ISPA UMR 1391, 33130 Villenave d'Ornon, France; aurore.kaisermann@inra.fr

* Correspondence: aurore.kaisermann@inra.fr ; lisa.wingate@inra.fr; Tel.: +33 557 12 25 96

Table S1. Characteristics of sites sampled for soil gas exchange. The two names in bold represent the two fertilized parcels in manipulation field experiment. The nine underlined names represent the nine soils used in the ammono-nitrate addition experiment. Altitude, mean annual temperature (MAT), and precipitation (MAP) are estimated from the literature. VW is the volumetric water content, MBC and MBN are the microbial biomass C and N, DOC and DN are the dissolved organic C and N.

SiteID	Country	Site	Landuse	Latitude	Longitude	Altitude (m)	MAT (°C)	MAP (mm)	pH (-)	Bulk Density (g.cm-3)	VW ($cm^3.cm^{-3}$)	MBC ($ug.g^{-1}$)	MBN ($ug.g^{-1}$)	DOC ($ug.g^{-1}$)	DN ($ug.g^{-1}$)	NO3 ($ug.g^{-1}$)	NH4 ($ug.g^{-1}$)
ES-Amo	Spain (ES)	Amoladeras	Grassland	36.8	-2.3	34	18.5	230	8.5	0.93	0.12	1027	112	90	31	27	4
ES-Bal	Spain (ES)	Balsablanca	Grassland	36.9	-2.0	200	18.5	220	8.5	0.89	0.10	650	57	83	23	20	3
CH-Cha	Switzerland (CH)	Chamau	Grassland	47.2	8.4	393	9.5	1136	5.4	0.69	0.15	963	84	71	69	76	12
PT-Cor	Portugal (PT)	Coruche	Forest	39.1	-8.3	156	17	656	5.8	1.13	0.11	154	14	64	30	1	47
CH-Dav	Switzerland (CH)	Davos	Forest	46.8	9.9	1639	2.8	1062	4.2	0.33	0.21	1447	145	276	37	3	31
CH-Fru	Switzerland (CH)	Fruebuel	Grassland	47.1	8.5	982	7.2	1651	4.8	0.74	0.18	903	98	182	167	160	48
DE-Hai	Germany (DE)	Hainich	Forest	51.1	10.5	463	7.9	646	5.7	0.88	0.25	640	NA	146	173	125	58
FR-Hes	France (FR)	Hesse	Forest	48.7	7.1	313	9.7	650	4.8	0.87	0.18	509	53	127	45	3	42
SE-Hyl	Sweden (SE)	Hyltemossa	Forest	56.1	13.4	111	7	830	3.7	0.52	0.12	854	110	157	53	1	66
FI-Hyy	Finland (FI)	Hyytiala	Forest	61.8	24.3	187	3.8	709	4.3	0.51	0.23	1058	120	273	29	3	12
CH-Lae	Switzerland (CH)	Laegern	Forest	47.1	8.5	866	8.3	1100	6.1	0.78	0.20	813	22	77	95	94	8
FR-Lou2	France (FR)	Lacueuille_Cont	Grassland	45.6	2.7	1041	7.9	897	4.9	0.55	0.22	2304	190	267	101	115	18
FR-Lqu1	France (FR)	Lacueuille_Fert	Grassland	45.6	2.7	1041	7.9	897	4.2	0.54	0.16	1015	7	305	262	278	57
DE-Lei	Germany (DE)	Leinefelde	Forest	51.3	10.4	474	7.6	775	5.0	0.88	0.15	542	55	102	56	52	29
PT-Mit	Portugal (PT)	Mitra	Forest	38.5	-8.0	240	15.6	656	6.0	0.80	0.11	479	52	75	18	9	10
SE-Nor	Sweden (SE)	Norunda	Forest	60.1	17.5	71	5.6	544	4.4	0.55	0.20	1258	155	94	25	1	36
CH-Oe2	Switzerland (CH)	Oensingen	Agrosystem	47.3	7.7	452	9.2	1100	6.9	0.89	0.17	552	43	42	19	18	3
IL-Reh	Israel (IL)	Rehovot	Agrosystem	31.9	34.8	50	19.7	185	7.9	1.01	0.15	362	31	71	27	25	3
SE-Ros2	Sweden (SE)	Rosinedal_Cont	Forest	64.2	19.7	145	1.8	614	4.6	0.86	0.12	99	5	132	16	3	15
SE-Ros1	Sweden (SE)	Rosinedal_Fert	Forest	64.2	19.7	145	1.8	614	4.3	0.81	0.12	151	13	211	52	39	41
DK-Sor	Denmark (DK)	Soro	Forest	55.5	11.6	45	8.5	564	4.2	0.63	0.17	569	58	95	42	34	29
SE-Svo	Sweden (SE)	Svartberget	Forest	64.2	19.8	161	1.8	614	4.0	0.55	0.22	919	112	153	19	1	9
ES-Ube2	Spain (ES)	Ubeda_noVeg	Agrosystem	37.9	-3.2	366	14.8	20.4	8.6	0.86	0.12	766	54	110	15	4	4
ES-Ube1	Spain (ES)	Ubeda_Veg	Agrosystem	37.9	-3.2	366	14.8	20.4	8.4	0.99	0.12	795	63	105	40	40	3
FI-Var1	Finland (FI)	Varrio1	Forest	67.8	29.6	400	-1	660	5.2	0.76	0.11	212	19	150	14	1	5
FI-Var2	Finland (FI)	Varrio2	Forest	67.8	29.6	400	-1	660	4.9	0.76	0.13	546	73	104	17	1	14
IL-Yat	Israel (IL)	Yatir	Forest	31.3	35.1	661	17.9	292	8.6	0.87	0.16	1240	144	151	13	2	1

Table S2. Explanatory power of each soil properties for the three COS fluxes across the 27 European soils measured with the marginal R^2 value of the linear mixed model with single soil properties. The significance of correlations has been tested with an analysis of variance. Abbreviations are: FCOS, net COS flux; k, COS hydrolysis rate; P, COS production rate; MBC, microbial biomass C; MBN, microbial biomass N; Ninor, inorganic N content (i.e. nitrate + ammonium); NO3, nitrate; NH4, ammonium; Redox, potential redox; BD, bulk density; VW, volumetric water content.

	FCOS		P		k	
Predictors	R^2	P value	R^2	P value	R^2	P value
MBC	0.20	<0.0001	0.05	0.04	0.16	<0.0001
MBN	0.37	<0.0001	0.00	0.70	0.34	<0.0001
DOC	0.00	0.10	0.10	0.01	0.00	0.73
DN	0.18	<0.0001	0.54	<0.0001	0.14	<0.0001
Ninor	0.21	<0.0001	0.41	<0.0001	0.18	<0.0001
NO3	0.22	<0.0001	0.43	<0.0001	0.16	<0.0001
NH4	0.1	0.005	0.28	<0.0001	0.14	<0.0001
pH	0.00	0.70	0.16	<0.0001	0.08	0.01
Redox	0.00	0.87	0.21	<0.0001	0.05	0.06
BD	0.12	0.00	0.05	0.05	0.01	0.46
VW	0.03	0.11	0.13	<0.002	0.00	0.75

Table S3. Statistical analysis to test if the slopes are significantly different in Figure 3b.

Statistical analysis to test the slope of linear models of Figure 3b

1/ Comparison of the three groups together

```
> mod1 <- aov(k ~ MBC*Groups, data=Mean_survey) ; summary(mod1)
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
MBC	1	0.0364	0.0364	16.733	0.000523	***
Groups	2	0.12125	0.06063	27.875	1.23e-06	***
MBC:Groups	2	0.03451	0.01725	7.933	0.002715	**
Residuals	21	0.04568	0.00218			

```
> mod2 <- aov(k ~ MBC+Groups, data=Mean_survey) ; summary(mod2)
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
MBC	1	0.0364	0.0364	10.44	0.00369	**
Groups	2	0.12125	0.06063	17.39	2.51e-05	***
Residuals	23	0.08019	0.00349			

```
> anova(mod1,mod2)
Model 1: k ~ MBC * Groups
Model 2: k ~ MBC + Groups
      Res.Df Sum of Sq      F     Pr(>F)
1         21
2         23 -0.034508 7.9329 0.002715  **
```

2/ Comparison of group 1 and 2
("Low NO3 content all pH" vs "High NO3 content acidic pH")

```
> Subset      <- subset(Mean_survey, Groups!="3. High NO3 alkaline pH")
> mod1 <- aov(k ~ MBC*Groups, data=Subset) ; summary(mod1)
            Df  Sum Sq Mean Sq F value   Pr(>F)
MBC          1 0.02561 0.02661  12.659   0.0021 **
Groups       1 0.05779 0.05779  27.488 4.63e-05 ***
MBC:Groups   1 0.00314 0.00314   1.492   0.2368
Residuals   19 0.03995 0.00210

> mod2 <- aov(k ~ MBC+Groups, data= Subset) ; summary(mod2)
            Df  Sum Sq Mean Sq F value   Pr(>F)
MBC          1 0.02561 0.02661   12.36  0.00218 **
Groups       1 0.05779 0.05779   26.83 4.55e-05 ***
Residuals   20 0.04308 0.00215
```

3/ Comparison of group 1 and 3
("Low NO3 content all pH" vs "High NO3 content alkaline pH")

```
> Subset      <- subset(Mean_survey, Groups!="2. High NO3 acidic pH")
> mod1 <- aov(k ~ MBC*Groups, data=Subset) ; summary(mod1)
            Df  Sum Sq Mean Sq F value  Pr(>F)
MBC          1 0.02029 0.02029   6.425 0.02490 *
Groups       1 0.02484 0.02484   7.864 0.01491 *
MBC:Groups   1 0.03428 0.03428  10.853 0.00581 **
Residuals   13 0.04107 0.00316

> mod2 <- aov(k ~ MBC+Groups, data= Subset) ; summary(mod2)
            Df  Sum Sq  Mean Sq F value Pr(>F)
MBC          1 0.02029 0.020295   3.771 0.0726 .
Groups       1 0.02484 0.024843   4.616 0.0497 *
Residuals   14 0.07535 0.005382
```

4/ Comparison of group 2 and 3
(" High NO3 content acidic pH" vs "High NO3 content alkaline pH")

```
> Subset      <- subset(Mean_survey, Groups!="1. Low  NO3 all pH")
> mod1 <- aov(k ~ MBC*Groups, data=Subset) ; summary(mod1)
            Df  Sum Sq Mean Sq F value   Pr(>F)
MBC          1 0.03633 0.03633   35.15 0.000145 ***
Groups       1 0.11039 0.11039  106.78 1.18e-06 ***
MBC:Groups   1 0.02694 0.02694   26.06 0.000461 ***
Residuals   10 0.01034 0.00103

> mod2 <- aov(k ~ MBC+Groups, data= Subset) ; summary(mod2)
            Df  Sum Sq Mean Sq F value   Pr(>F)
MBC          1 0.03633 0.03633   10.72 0.007410 **
Groups       1 0.11039 0.11039   32.57 0.000137 ***
Residuals   11 0.03728 0.00339
```

5/ Coefficients of the three lm

```
# "1. Low  NO3 all pH"
green      <- subset(Mean_survey, Groups =="1. Low  NO3 all pH")
lm(k~MBC, data=green)
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 1.710e-01  3.133e-02   5.459 0.000198 ***
MBC         5.503e-05  3.693e-05   1.490 0.164278

# "2. High  NO3 acidic pH"
purpleAcid <- subset(Mean_survey, Groups =="2. High NO3 acidic pH")
lm(k~MBC, data=purpleAcid)
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 3.091e-02  1.402e-02   2.202   0.0588 .
MBC         1.040e-04  1.397e-05   7.443 7.31e-05 ***

# "3. High  NO3 alkaline pH"
purpleAlkaline    <- subset(Mean_survey, Groups =="3. High NO3 alkaline pH")
 lm(k~MBC, data=purpleAlkaline)
Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.0250261  0.0831019  -0.301   0.7917
MBC          0.0004575  0.0001110   4.122   0.0541 .
```