Supplementary Information

Tables

Table S. 1. PHREEQC input data for of solution chemistry of microcosm soil water extracts. Chemical component concentrations units of mg kg^{-1} except for pH (unitless) and temperature (^{0}C)

Description[ii]	Ca^{2+}	Mg^{2+}	Na^+	K^+	NO_3^-	NH_4^+	Cl^-	SO_4^{-2}	P	DIC	pH	Temperature
CaOxCultivated1	5.83	1.66	8.75	21.05	5.95	0.64	13.42	4.28	3.65	1.08	7.54	21.62
ControlCultivated1	4.96	1.56	11.38	25.08	6.32	0.67	17.67	4.52	4.60	1.18	7.18	21.62
FrassCultivated1	23.42	12.07	43.40	81.90	5.71	4.42	45.89	11.75	18.60	2.64	7.81	21.62
CaOxUncultivated1	14.83	4.90	13.68	39.07	78.08	1.07	23.84	11.21	0.48	0.28	6.64	21.62
ControlUncultivated1	16.05	5.27	14.22	39.59	83.00	0.95	25.40	11.17	0.44	0.28	6.62	21.62
FrassUncultivated1	42.17	41.67	225.85	162.08	83.60	5.52	264.38	51.28	4.35	3.19	7.39	21.62
CaOxCultivated3	9.40	2.18	8.45	20.32	5.95	0.78	12.84	2.90	4.40	1.41	7.76	23.33
ControlCultivated3	9.07	2.81	10.18	23.53	7.19	1.10	16.85	2.75	6.00	1.28	7.30	23.33
FrassCultivated3	22.39	10.48	35.65	68.34	5.71	3.31	40.50	10.52	17.16	3.42	7.77	23.33
CaOxUncultivated3	15.92	5.90	12.65	37.48	78.08	0.98	23.28	11.21	0.80	0.66	6.69	23.33
ControlUncultivated3	17.88	6.29	12.98	38.76	74.53	0.95	24.17	10.68	0.91	0.52	6.44	23.33
FrassUncultivated3	35.66	33.35	191.76	124.89	106.98	3.24	241.63	47.83	5.72	5.02	7.54	23.33
CaOxCultivated7	9.15	2.97	6.87	19.95	11.29	0.62	13.41	1.31	4.39	2.54	8.15	22.26
ControlCultivated7	5.18	2.16	8.54	23.01	8.94	1.26	17.25	0.00	5.91	1.55	7.32	22.26
FrassCultivated7	22.24	9.89	35.67	69.37	0.83	2.62	43.74	9.33	18.34	4.58	7.90	22.26
CaOxUncultivated7	17.71	6.13	10.92	38.22	90.74	0.55	23.28	11.03	0.85	1.43	6.90	22.26
ControlUncultivated7	21.15	6.92	11.31	38.16	97.98	0.33	24.41	11.30	1.08	1.11	6.72	22.26
FrassUncultivated7	36.44	31.53	195.64	130.02	13.21	2.76	269.24	48.17	5.27	8.32	7.60	22.26

[i]Chemical components DIC = dissolved inorganic C, Ca^{2+} = calcium, Cl^- = chlorine, K^+ = potassium, Mg^{2+} = magnesium, Na^+ = sodium, P = phosphate (PO_4^{3-}) expressed as equivalent elemental phosphorus, NO_3^- = nitrate, NH_4^+ = ammonium, SO_4^{-2} = sulfate

[ii]Description names follow the format SubstrateDisturbanceDay for substrate treatments calcium oxalate (CaOx), termite frass or control, Disturbance levels Cultivated or Uncultivated and Day 1, 3 or 7 of the week-long incubation period.

Table S. 2. Carbon dioxide (CO_2) produced (%), oxygen (O_2) consumed (%) and apparent respiratory quotient (ARQ) values with standard deviation (sd) of values measured over a 40-second period of individual microcosms for each 12-hourly measurement loop. The letters in die Microcosms column represent two levels of disturbance (cultivated A-I and uncultivated J-R), each with three substrate treatments applied in triplicate (Control A-C and J-L, frass addition = D-F and M-O, calcium oxalate addition = G-I and P-R). Measurement loops of microcosms where flow rates underperformed were omitted.

Day	Microcosm	Loop	CO_2	sd CO_2	O_2	sd O_2	ARQ	sd ARQ
1	H	1	0.3687	0.0027	0.2994	0.0020	0.9360	0.0094
1	I	1	0.3151	0.0014	0.2539	0.0014	0.9431	0.0068
1	H	2	0.2466	0.0018	0.2022	0.0013	0.9267	0.0089
1	I	2	0.2283	0.0009	0.1836	0.0008	0.9451	0.0053
1	A	1	0.2980	0.0014	0.2392	0.0043	0.9467	0.0177
1	B	1	0.2678	0.0011	0.2062	0.0025	0.9871	0.0128
1	C	1	0.2152	0.0009	0.1180	0.0023	1.3862	0.0275
1	A	2	0.2392	0.0011	0.1404	0.0019	1.2948	0.0181
1	B	2	0.2416	0.0011	0.1957	0.0016	0.9384	0.0086
1	C	2	0.2650	0.0013	0.2243	0.0023	0.8977	0.0104
1	D	2	2.1142	0.0167	1.8513	0.0111	0.8679	0.0086
1	E	2	1.8624	0.0088	1.6104	0.0124	0.8789	0.0079
1	F	2	1.8695	0.0096	1.6357	0.0102	0.8686	0.0070
1	P	1	0.0857	0.0006	0.0626	0.0003	1.0411	0.0084
1	Q	1	0.0794	0.0006	0.0562	0.0008	1.0738	0.0169
1	R	1	0.1945	0.0013	0.0945	0.0012	1.5646	0.0230
1	P	2	0.0536	0.0004	0.0451	0.0004	0.9023	0.0099
1	Q	2	0.0952	0.0005	0.0763	0.0007	0.9479	0.0101

Day	Microcosm	Loop	CO_2	sd CO_2	O_2	sd O_2	ARQ	sd ARQ
1	R	2	0.1203	0.0008	0.0583	0.0014	1.5676	0.0404
1	J	1	0.1446	0.0006	0.0784	0.0011	1.4015	0.0199
1	K	1	0.1789	0.0010	0.0885	0.0010	1.5352	0.0190
1	L	1	0.2885	0.0025	0.1443	0.0021	1.5192	0.0259
1	J	2	0.0875	0.0005	0.0483	0.0006	1.3764	0.0175
1	K	2	0.1208	0.0007	0.0636	0.0012	1.4423	0.0288
1	L	2	0.1505	0.0010	0.0738	0.0010	1.5500	0.0229
1	M	1	2.4089	0.0129	1.9454	0.0121	0.9410	0.0077
1	N	1	2.6226	0.0218	2.1829	0.0184	0.9131	0.0108
1	O	1	2.9150	0.0150	2.5811	0.0154	0.8583	0.0068
1	M	2	1.9352	0.0078	1.6634	0.0076	0.8842	0.0054
1	N	2	2.7624	0.0181	2.3603	0.0134	0.8895	0.0077
1	O	2	2.9061	0.0127	2.4262	0.0105	0.9103	0.0056
2	H	1	0.2282	0.0016	0.1655	0.0012	1.0480	0.0107
2	I	1	0.1988	0.0007	0.1414	0.0008	1.0685	0.0068
2	H	2	0.2253	0.0010	0.1570	0.0008	1.0901	0.0074
2	I	2	0.1913	0.0013	0.1286	0.0007	1.1306	0.0101
2	A	1	0.1762	0.0012	0.1290	0.0014	1.0386	0.0131
2	B	1	0.1648	0.0008	0.1224	0.0007	1.0235	0.0074
2	C	1	0.1546	0.0008	0.0771	0.0019	1.5241	0.0380
2	A	2	0.2027	0.0013	0.1057	0.0016	1.4574	0.0244

Day	Microcosm	Loop	CO_2	sd CO_2	O_2	sd O_2	ARQ	sd ARQ
2	B	2	0.2090	0.0010	0.1476	0.0015	1.0764	0.0119
2	C	2	0.2268	0.0009	0.1698	0.0012	1.0150	0.0082
2	D	1	1.7239	0.0103	0.8951	0.0183	1.4636	0.0312
2	E	1	1.6188	0.0055	1.3494	0.0097	0.9117	0.0073
2	F	1	1.6532	0.0053	1.3580	0.0080	0.9252	0.0062
2	D	2	1.6671	0.0076	1.4234	0.0120	0.8901	0.0085
2	E	2	1.5782	0.0134	1.3237	0.0082	0.9061	0.0095
2	F	2	1.5509	0.0060	1.2798	0.0056	0.9210	0.0054
2	P	1	0.0454	0.0004	0.0374	0.0003	0.9238	0.0118
2	Q	1	0.0569	0.0005	0.0467	0.0003	0.9256	0.0096
2	R	1	0.0610	0.0004	0.0291	0.0006	1.5906	0.0333
2	P	2	0.0467	0.0003	0.0383	0.0003	0.9265	0.0091
2	Q	2	0.0753	0.0005	0.0605	0.0007	0.9454	0.0131
2	R	2	0.0674	0.0006	0.0351	0.0008	1.4605	0.0380
2	J	1	0.0358	0.0004	0.0193	0.0004	1.4084	0.0346
2	K	1	0.0478	0.0003	0.0265	0.0006	1.3713	0.0300
2	L	1	0.0719	0.0006	0.0385	0.0007	1.4198	0.0273
2	J	2	0.0513	0.0004	0.0335	0.0004	1.1632	0.0161
2	K	2	0.0726	0.0004	0.0452	0.0007	1.2215	0.0187
2	L	2	0.0945	0.0009	0.0547	0.0011	1.3137	0.0287
2	M	1	1.4184	0.0051	1.2244	0.0047	0.8804	0.0047

Day	Microcosm	Loop	CO_2	sd CO_2	O_2	sd O_2	ARQ	sd ARQ
2	N	1	1.6643	0.0104	1.4459	0.0080	0.8748	0.0073
2	O	1	1.7070	0.0042	1.3762	0.0047	0.9427	0.0040
2	M	2	1.4076	0.0092	1.2468	0.0087	0.8580	0.0082
2	N	2	1.8830	0.0105	1.6801	0.0075	0.8518	0.0061
2	O	2	1.9276	0.0119	1.6420	0.0112	0.8922	0.0082
3	H	1	0.2105	0.0009	0.1430	0.0013	1.1188	0.0114
3	I	1	0.1620	0.0011	0.1058	0.0006	1.1639	0.0103
3	H	2	0.2348	0.0010	0.1586	0.0010	1.1255	0.0085
3	I	2	0.2345	0.0013	0.1522	0.0008	1.1705	0.0088
3	A	1	0.1225	0.0009	0.0833	0.0009	1.1179	0.0154
3	B	1	0.0953	0.0005	0.0640	0.0008	1.1317	0.0149
3	C	1	0.0818	0.0006	0.0402	0.0014	1.5459	0.0545
3	A	2	0.2130	0.0011	0.1074	0.0022	1.5074	0.0323
3	B	2	0.2172	0.0013	0.1524	0.0012	1.0830	0.0106
3	C	2	0.2327	0.0009	0.1713	0.0017	1.0324	0.0113
3	D	1	1.3016	0.0069	0.6638	0.0113	1.4901	0.0267
3	E	1	1.2293	0.0077	1.0257	0.0069	0.9109	0.0084
3	F	1	1.1290	0.0039	0.9125	0.0030	0.9403	0.0045
3	P	1	0.0431	0.0004	0.0305	0.0003	1.0731	0.0146
3	Q	1	0.0636	0.0005	0.0447	0.0006	1.0826	0.0161
3	R	1	0.1007	0.0004	0.0478	0.0009	1.6030	0.0314

Day	Microcosm	Loop	CO_2	sd CO_2	O_2	sd O_2	ARQ	sd ARQ
3	P	2	0.0883	0.0005	0.0568	0.0004	1.1823	0.0114
3	Q	2	0.0924	0.0007	0.0585	0.0007	1.1999	0.0169
3	R	2	0.0863	0.0007	0.0189	0.0266	3.4619	4.8679
3	J	1	0.0306	0.0004	0.0181	0.0005	1.2842	0.0377
3	K	1	0.0445	0.0004	0.0251	0.0006	1.3457	0.0358
3	L	1	0.0818	0.0006	0.0479	0.0008	1.2965	0.0236
3	J	2	0.0408	0.0004	0.0231	0.0006	1.3438	0.0349
3	K	2	0.0429	0.0004	0.0242	0.0006	1.3500	0.0338
3	L	2	0.0738	0.0004	0.0403	0.0006	1.3916	0.0232
3	M	1	1.2726	0.0079	1.1213	0.0077	0.8626	0.0080
3	N	1	1.4824	0.0062	1.2769	0.0052	0.8823	0.0052
3	O	1	1.8405	0.0112	1.5483	0.0087	0.9034	0.0075
3	M	2	1.4029	0.0071	1.4268	0.0073	0.7473	0.0054
3	N	2	1.5524	0.0071	1.3904	0.0087	0.8486	0.0066
3	O	2	1.7342	0.0092	1.5865	0.0077	0.8307	0.0060
4	H	1	0.1829	0.0008	0.1168	0.0008	1.1903	0.0093
4	I	1	0.1660	0.0005	0.1039	0.0005	1.2144	0.0068
4	H	2	0.1101	0.0073	0.0884	0.0057	0.9464	0.0876
4	I	2	0.0962	0.0083	0.0832	0.0070	0.8783	0.1057
4	A	1	0.1264	0.0006	0.0894	0.0015	1.0747	0.0183
4	B	1	0.1147	0.0009	0.0781	0.0005	1.1159	0.0110

Day	Microcosm	Loop	CO_2	sd CO_2	O_2	sd O_2	ARQ	sd ARQ
4	C	1	0.0981	0.0004	0.0463	0.0014	1.6091	0.0484
4	A	2	0.1847	0.0008	0.0923	0.0014	1.5203	0.0243
4	B	2	0.1865	0.0010	0.1283	0.0009	1.1049	0.0100
4	C	2	0.2079	0.0011	0.1493	0.0007	1.0587	0.0076
5	P	1	0.0765	0.0065	0.0653	0.0049	0.8899	0.1011
5	Q	1	0.0759	0.0071	0.0647	0.0049	0.8918	0.1075
5	R	1	0.0768	0.0074	0.0593	0.0050	0.9837	0.1252
5	P	2	0.0261	0.0003	0.0140	0.0003	1.4148	0.0343
5	Q	2	0.0405	0.0003	0.0220	0.0004	1.3968	0.0267
5	R	2	0.0459	0.0004	0.0332	0.0243	1.0495	0.7674
5	J	1	0.0788	0.0069	0.0577	0.0048	1.0383	0.1252
5	K	1	0.0778	0.0074	0.0569	0.0049	1.0398	0.1337
5	L	1	0.0773	0.0068	0.0566	0.0044	1.0383	0.1218
5	J	2	0.0204	0.0004	0.0100	0.0002	1.5592	0.0452
5	K	2	0.0265	0.0003	0.0121	0.0003	1.6691	0.0510
5	L	2	0.0419	0.0004	0.0196	0.0004	1.6260	0.0335
5	M	1	0.0770	0.0065	0.0632	0.0046	0.9256	0.1032
5	N	1	0.0769	0.0065	0.0640	0.0049	0.9135	0.1044
5	O	1	0.0760	0.0066	0.0630	0.0046	0.9168	0.1038
5	M	2	0.7917	0.0029	0.7043	0.0026	0.8543	0.0044
5	N	2	1.1786	0.0067	1.0333	0.0061	0.8669	0.0071

Day	Microcosm	Loop	CO_2	sd CO_2	O_2	sd O_2	ARQ	sd ARQ
5	O	2	1.1053	0.0080	0.9483	0.0069	0.8858	0.0091
6	H	1	0.1819	0.0009	0.1195	0.0008	1.1572	0.0094
6	I	1	0.1933	0.0012	0.1273	0.0007	1.1543	0.0094
6	H	2	0.1354	0.0007	0.0905	0.0004	1.1373	0.0075
6	I	2	0.1493	0.0010	0.0957	0.0005	1.1863	0.0103
6	A	1	0.1731	0.0013	0.1123	0.0007	1.1717	0.0111
6	B	1	0.1739	0.0009	0.1119	0.0008	1.1809	0.0105
6	C	1	0.1997	0.0009	0.0967	0.0023	1.5697	0.0379
6	A	2	0.1222	0.0007	0.0572	0.0017	1.6243	0.0486
6	B	2	0.1342	0.0005	0.0843	0.0012	1.2094	0.0179
6	C	2	0.1555	0.0007	0.1049	0.0007	1.1274	0.0093
6	P	1	0.0224	0.0003	0.0111	0.0004	1.5302	0.0576
6	Q	1	0.0384	0.0005	0.0198	0.0003	1.4738	0.0298
6	R	1	0.0507	0.0004	0.0177	0.0006	2.1767	0.0747
6	P	2	0.0236	0.0004	0.0121	0.0003	1.4807	0.0425
6	Q	2	0.0519	0.0004	0.0255	0.0004	1.5478	0.0294
6	R	2	0.0396	0.0003	0.0278	0.0252	1.0830	0.9826
6	J	1	0.0161	0.0004	0.0072	0.0003	1.7076	0.0806
6	K	1	0.0225	0.0002	0.0103	0.0003	1.6595	0.0581
6	L	1	0.0391	0.0005	0.0181	0.0005	1.6386	0.0491
6	J	2	0.0276	0.0003	0.0127	0.0003	1.6579	0.0466

Day	Microcosm	Loop	CO_2	sd CO_2	O_2	sd O_2	ARQ	sd ARQ
6	K	2	0.0316	0.0004	0.0138	0.0005	1.7363	0.0613
6	L	2	0.0385	0.0003	0.0170	0.0006	1.7225	0.0604
6	M	1	0.6842	0.0017	0.6116	0.0019	0.8502	0.0034
6	N	1	1.0592	0.0050	0.9283	0.0044	0.8672	0.0058
6	O	1	1.0236	0.0068	0.9051	0.0060	0.8595	0.0081
6	M	2	0.7984	0.0053	0.7031	0.0040	0.8629	0.0075
6	N	2	1.0656	0.0046	0.9383	0.0076	0.8631	0.0079
6	O	2	1.0086	0.0053	0.8736	0.0047	0.8774	0.0066
7	H	1	0.1555	0.0008	0.1023	0.0008	1.1556	0.0103
7	I	1	0.1633	0.0010	0.1047	0.0009	1.1853	0.0128
7	H	2	0.1482	0.0009	0.0949	0.0006	1.1877	0.0105
7	I	2	0.1497	0.0009	0.0950	0.0006	1.1977	0.0105
7	A	1	0.1107	0.0008	0.0626	0.0008	1.3449	0.0197
7	B	1	0.1101	0.0003	0.0621	0.0007	1.3481	0.0166
7	C	1	0.1096	0.0004	0.0490	0.0013	1.7003	0.0462
7	A	2	0.1437	0.0006	0.0671	0.0018	1.6275	0.0449
7	B	2	0.1420	0.0008	0.0880	0.0008	1.2264	0.0128
7	C	2	0.1644	0.0012	0.1101	0.0009	1.1349	0.0121
7	P	1	0.0176	0.0003	0.0083	0.0003	1.6078	0.0675
7	Q	1	0.0288	0.0003	0.0144	0.0003	1.5127	0.0344
7	R	1	0.0564	0.0003	0.0186	0.0005	2.3037	0.0623

Day	Microcosm	Loop	CO_2	sd CO_2	O_2	sd O_2	ARQ	sd ARQ
7	P	2	0.0183	0.0003	0.0091	0.0003	1.5255	0.0615
7	Q	2	0.0342	0.0004	0.0164	0.0005	1.5842	0.0484
7	R	2	0.0352	0.0004	0.0181	0.0003	1.4763	0.0322
7	J	1	0.0128	0.0002	0.0041	0.0003	2.3991	0.2101
7	K	1	0.0170	0.0003	0.0072	0.0003	1.7928	0.0830
7	L	1	0.0321	0.0004	0.0127	0.0004	1.9161	0.0690
7	J	2	0.0193	0.0003	0.0132	0.0003	1.1108	0.0339
7	K	2	0.0221	0.0003	0.0161	0.0003	1.0447	0.0263
7	L	2	0.0329	0.0002	0.0218	0.0004	1.1469	0.0209
7	M	1	0.5569	0.0032	0.4928	0.0020	0.8587	0.0060
7	N	1	0.7818	0.0026	0.6751	0.0044	0.8801	0.0064
7	O	1	0.9055	0.0037	0.7882	0.0037	0.8730	0.0055
7	M	2	0.5779	0.0027	0.5271	0.0022	0.8332	0.0052
7	N	2	0.8623	0.0041	0.7855	0.0040	0.8344	0.0058
7	O	2	0.8631	0.0038	0.7555	0.0054	0.8683	0.0072

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Table S. 3. Principal component (PC) loadings of changes in chemical properties (dpH, water-soluble calcium: dCa2+, dissolved organic carbon: dDOC, dissolved inorganic carbon: dDIC, ammonium: dNH4+, nitrate: dNO3-, nitrite: dNO2-, total organic carbon: dTOC and and total inorganic carbon: TIC) as variables explaining variance in soil microcosms.

Variable	PC1 loading	PC2 loading
dpH	-0.110	-0.421
dCa	0.053	-0.415
dC	-0.028	-0.403
dTIC	-0.414	-0.125
dTOC	-0.377	0.131
dDOC	0.359	0.158
dDIC	0.310	0.164
dN	-0.378	0.200
dNO_3^-	-0.386	0.209
dNO_2^-	0.369	0.217
dNH_4^+	-0.133	0.522

Table S. 4. Factors affecting apparent respiratory quotient (ARQ)

Factor	***Variations***	***Effect on ARQ***	***Effect on gas***	***Mechanism***	***References***
REDOX REACTIONS	Dissimilatory reduction	↑	↓ O2 consumption	Alternative oxidized compounds reduced during anaerobic respiration / fermentation.	(Angert *et al.*, 2015a; Coskun *et al.*, 2017; Dilly, 2001, 2003; Hodges *et al.*, 2019a; Hooper & DiSpirito, 2013; Swensen & Bakken, 1998)
	Abiotic reduction	↑	↓ O2 consumption	Redox reactions between inorganic soil components.	
	Chemolithoautotrophy	↓	↑ O2 consumption	Oxidation of inorganic or single-carbon compounds by autotrophic bacteria	
	Metal oxidation	↓	↑ O2 consumption	Re-aeration of soil induces oxidation of reduced compounds.	
SHIFT IN SUBSTRATE	Preferential mineralization of labile substrates	↑	↑ CO2 production	Respiration of organic acids (oxidized carbon).	(Angert et al., 2015a; Dilly, 2003; Hicks Pries et al., 2020a; Hodges et al., 2019a)
	Preferential mineralization of refractory compounds	↓	↓ CO2 production	Respiration of lipids, amino acids, and lignin (reduced carbon).	
CARBONATE EQUILIBRIUM	Carbonate precipitation	↑	↑ CO2 production	Reversible reactions:	

Factor	***Variations***	***Effect on ARQ***	***Effect on gas***	***Mechanism***	***References***
	Carbonate dissolution	↓	↓ CO2 production	$H_2CO_3 \rightleftharpoons HCO_3^- + H+$	
	Degassing of CO_2-rich soil water	↑	↑ CO2 production	$Ca^{2+} + 2HCO_3^-$ ó $CaCO_3 + H_2CO_3$	(Angert *et al.*, 2015a; Hodges *et al.*, 2019a)
	Dissolution of CO_2 gas in soil water	↓	↓ CO2 production	$H_2CO_3 \rightleftharpoons CO2 + H2O$	
ANABOLIC PROCESSES PARTITIONING CARBON TO BIOMASS	-	↑	↓ O2 consumption	More substrate decarboxylation (to obtain precursor metabolites for biomass growth) relative to oxidative phosphorylation via respiratory chain (for ATP production) i.e. greater carbon use efficiency.	(Dilly, 2003; Zheng *et al.*, 2019)
AUTOTROPHIC RESPIRATION	-	↑	↑ CO2 production	Heterotrophic respiration signals muted by that of plant roots.	(Hodges *et al.*, 2019a)

Factor	***Variations***	***Effect on ARQ***	***Effect on gas***	***Mechanism***	***References***
SILICATE WEATHERING BY CARBONIC ACID	-	↓	↓ CO_2 production	Protons displace basic cations from mineral structures and/ or participate in hydrolysis of minerals, driving further dissolution of CO_2 in soil water.	(Hodges *et al.*, 2019a; McBride, 1994)

Figures

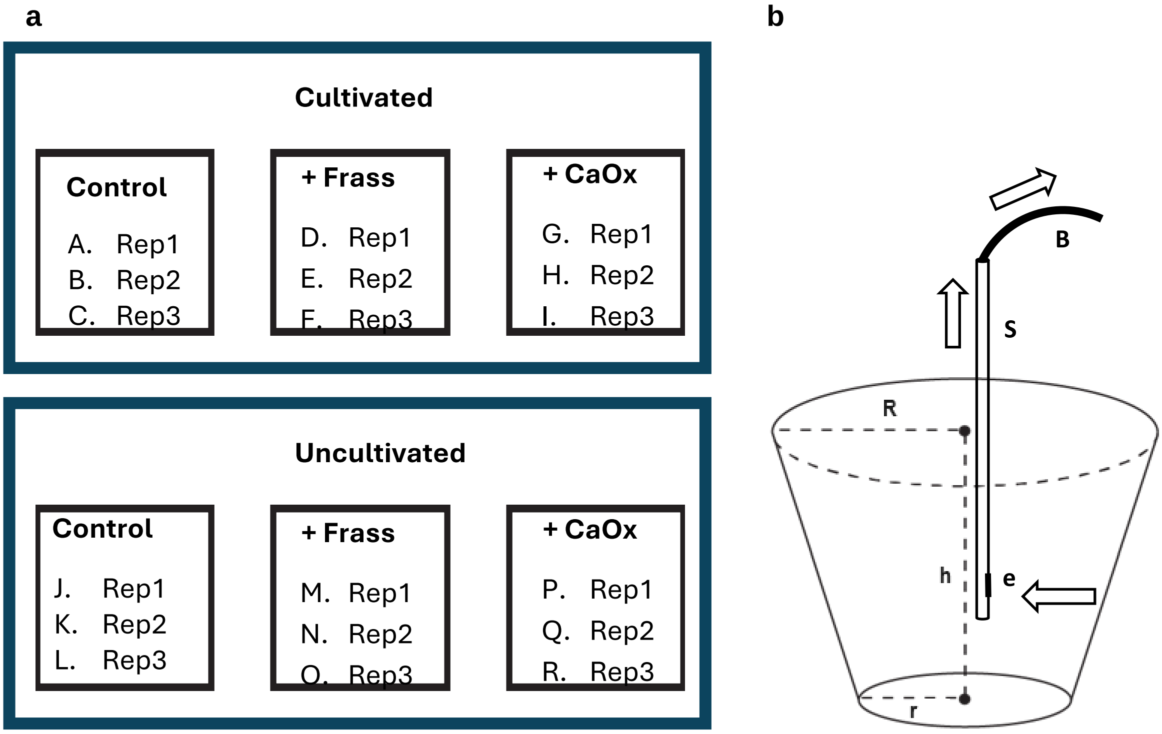

Figure S. 1. Left (a): Allocation of treatments to microcosms (containers labelled A-R) [CaOx] = 0.025 mmol g^{-1} soil. Frass applied at equivalent [CaOx] of 0.028 mmol g^{-1} soil and 0.016 mmol g^{-1} soil with frass collected from Renosterbos and oats field, respectively. Right (b): Truncated cone container dimensions: h = 18 cm (excluding 1 cm-depth rim which lid fits into), r = 8 cm, R = 9 cm. Gas enters through hole (e) in steel tube (S) and follows direction of flow indicated by arrows into the Bev-a-line tubing (B) which is connected to a manifold of solenoid valves.

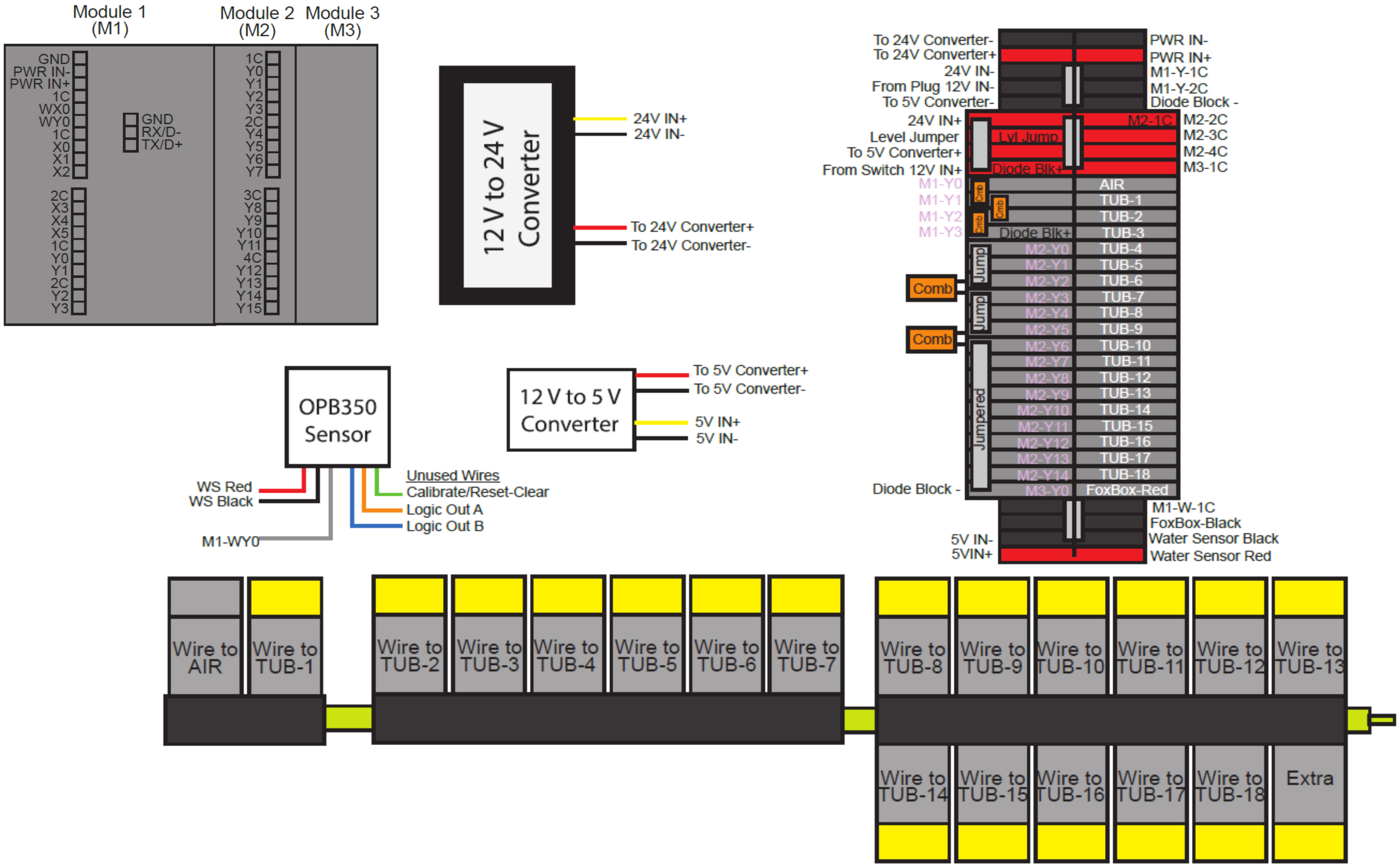

Figure S. 2. Wiring of the automated sampling system (programmable logic controller with three modules, terminal blocks, and a manifold of solenoid valves.

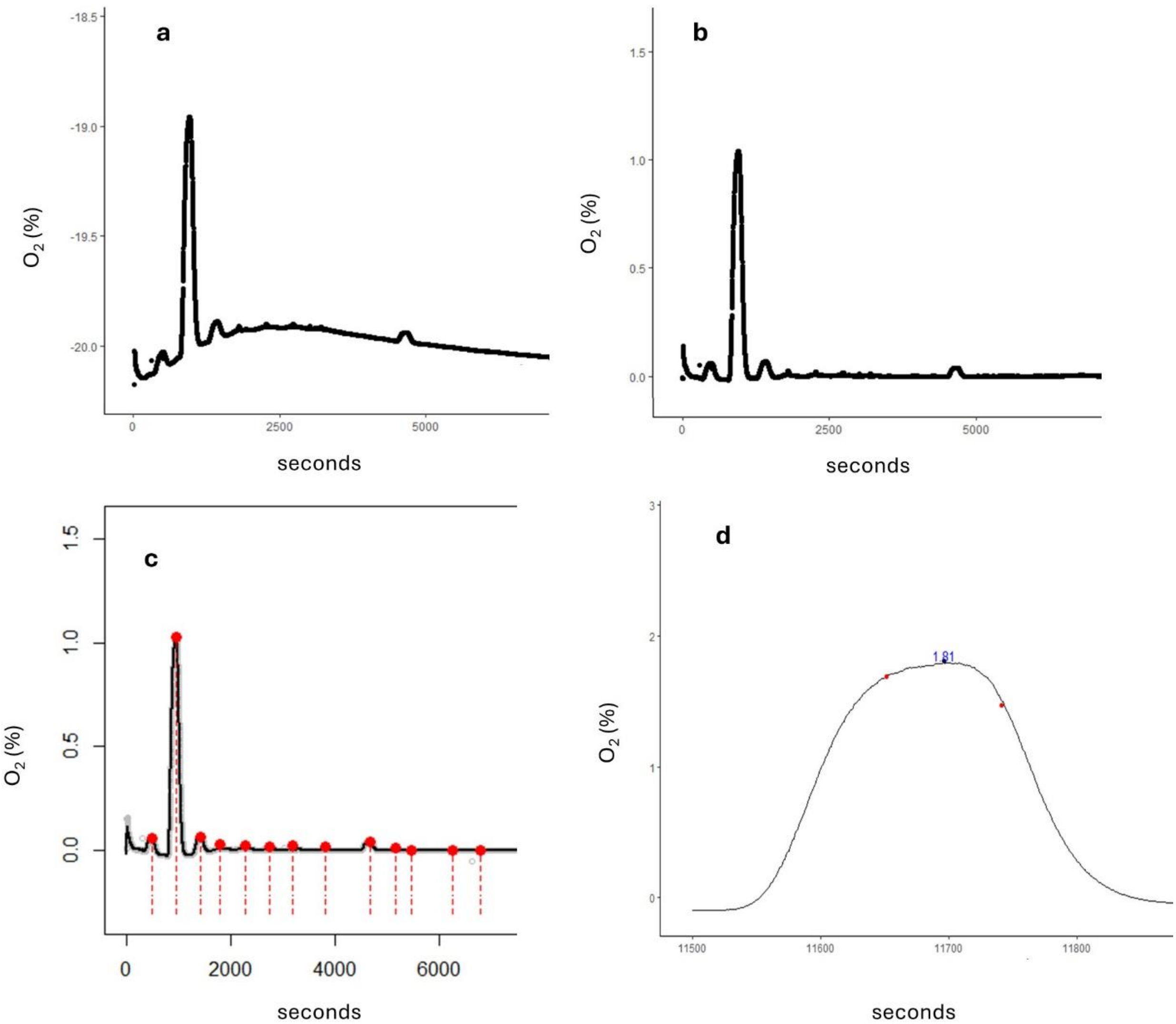

Figure S. 3. Example of oxygen (O_2) concentrations of microcosms and atmosphere, represented by peaks and baseline, respectively, (a) before and (b) after baseline correction using a rolling ball algorithm and selecting zero as the new baseline value. The dominant peak shows a frass treatment response. (c) Example of peak detection (local maxima indicated by red points) using the "argmax" function. (d) Example of a maximum O_2 concentration of a microcosm (blue point) during a single measurement period and an interval chosen for averaging over (red points).

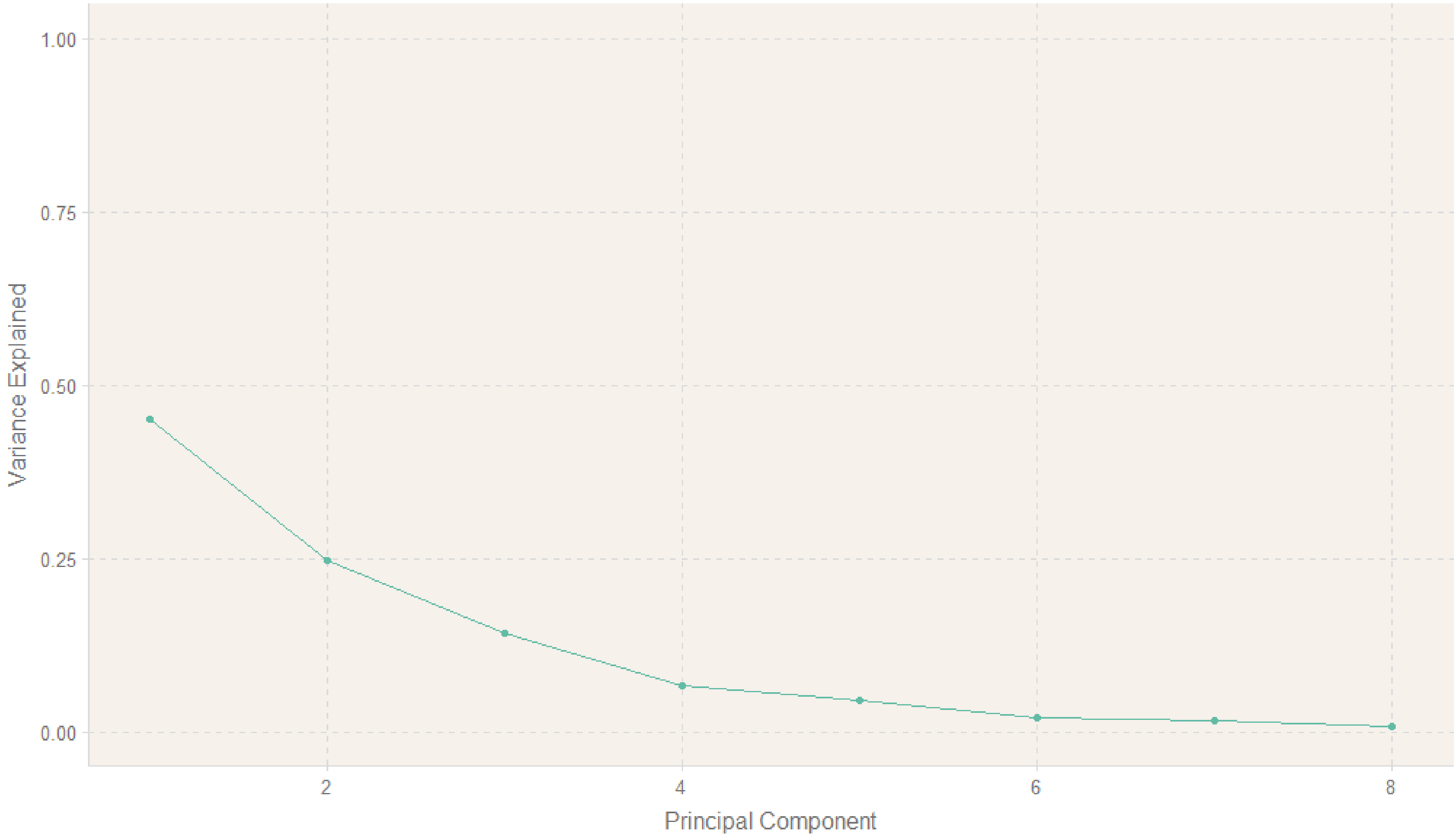

Figure S. 4. Scree plots showing proportion of variance explained by principal components with contributions of changes in chemical properties (dpH, water-soluble calcium: dCa2+, dissolved organic carbon: dDOC, dissolved inorganic carbon: dDIC, ammonium: dNH_4^+, nitrate: dNO_3^-, nitrite: dNO_2^-, total organic carbon: dTOC and total inorganic carbon: TIC)

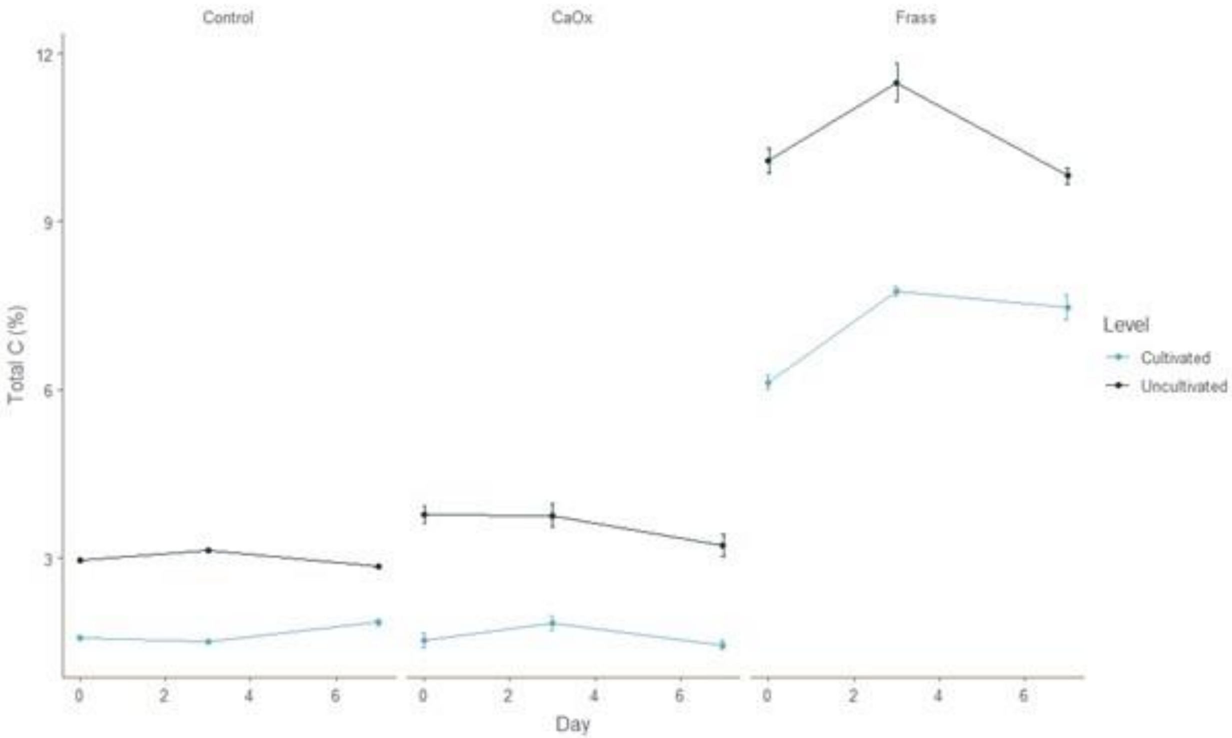

Figure S. 5. Total carbon (C) concentrations of microcosms on three separate days during one week for different substrate treatments and disturbance levels. Bars indicate standard error of measurement (SE) for triplicate measurements (biological replicates).

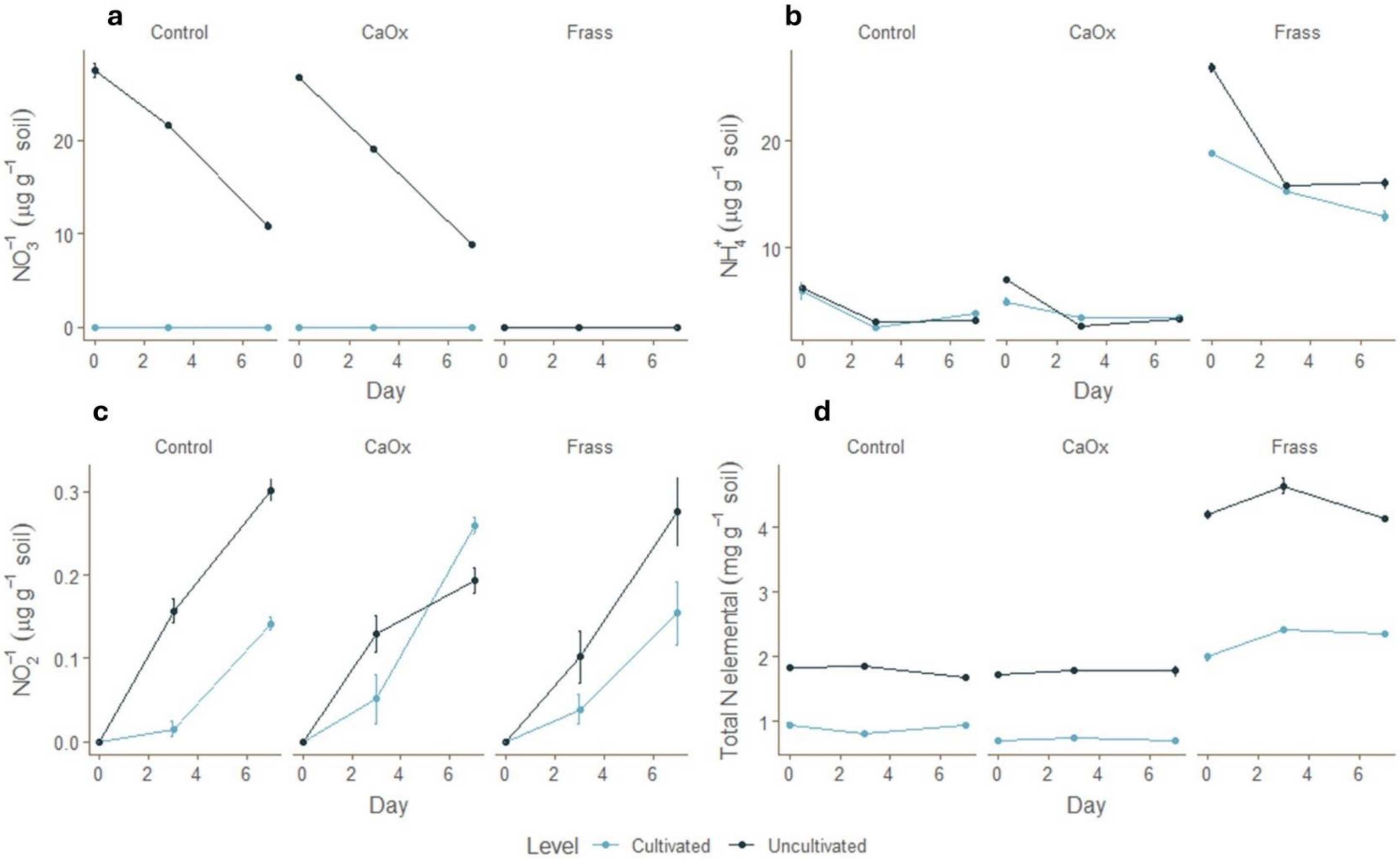

Figure S. 6. Active (salt-extractable) nitrate (NO_3^-, a), ammonium (NH_4^+, b), nitrite (NO_2^-, c) and total elemental nitrogen (N, d) content of microcosm soils with different substrate treatments (calcium oxalate i.e., CaOx, termite frass and a control) and disturbance levels (cultivated and uncultivated) on three days during one week of incubation. Bars indicate standard error of measurement (SE) for triplicate measurements (biological replicates).

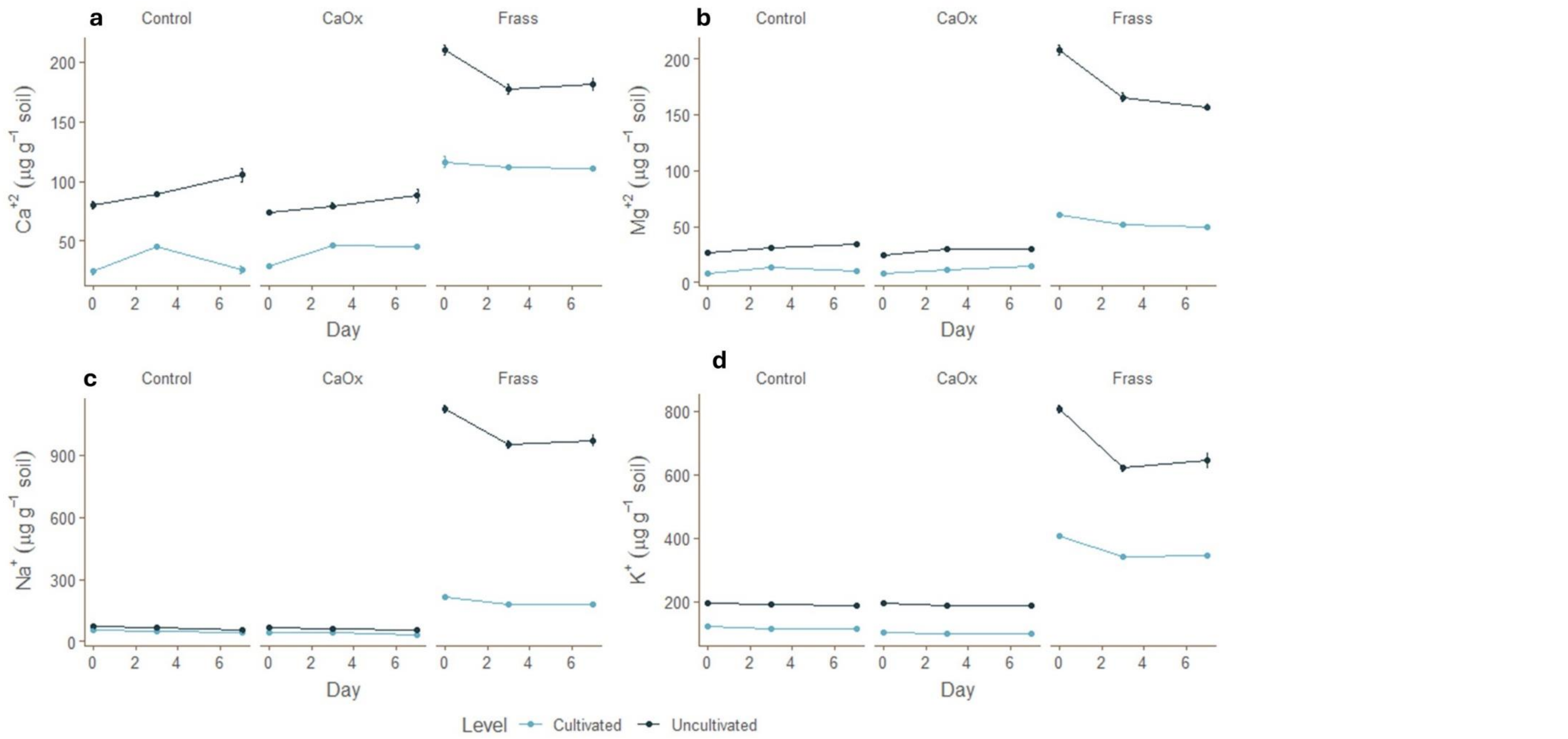

Figure S. 7. Water-soluble calcium (Ca^{2+}, a), magnesium (Mg^{2+}, b), sodium (Na, c) and potassium (K, d) of microcosms on three separate days during one week for different substrate treatments and disturbance levels. Bars indicate standard error of measurement (SE) for triplicate measurements (biological replicates).

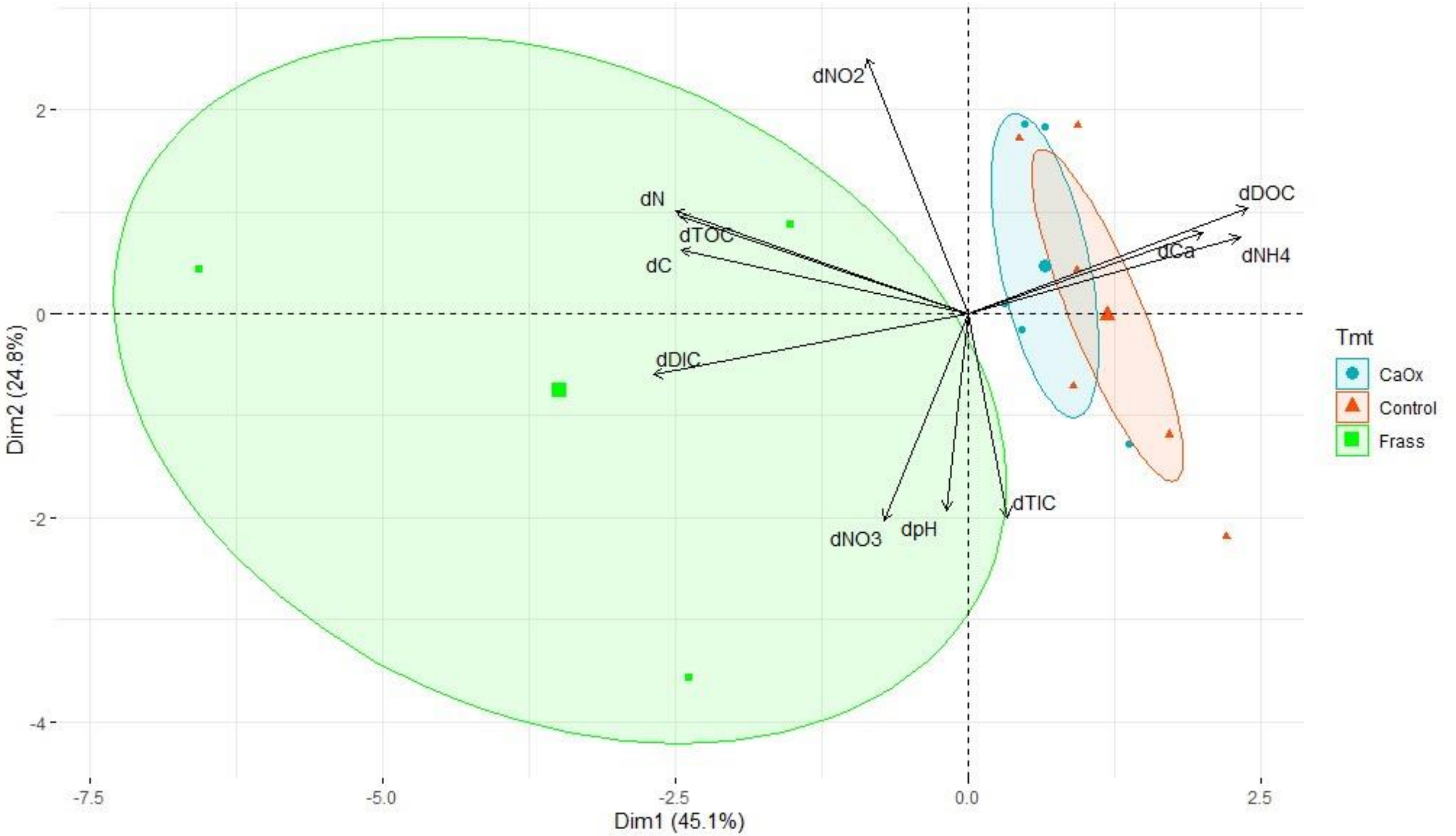

Figure S. 8. Principal component analysis (PCA) biplots showing the amount of variation of the dataset (termite-affected soil microcosms grouped by treatment) explained by changes (delta, d calculated as the difference between values on day 3 and day 1) in chemical properties (dpH, water-soluble calcium: dCa, dissolved organic carbon: dDOC, dissolved inorganic carbon: dDIC, ammonium: dNH_4, nitrate: dNO_3, nitrite: dNO_2,total organic carbon: dTOC and total inorganic carbon: TIC).

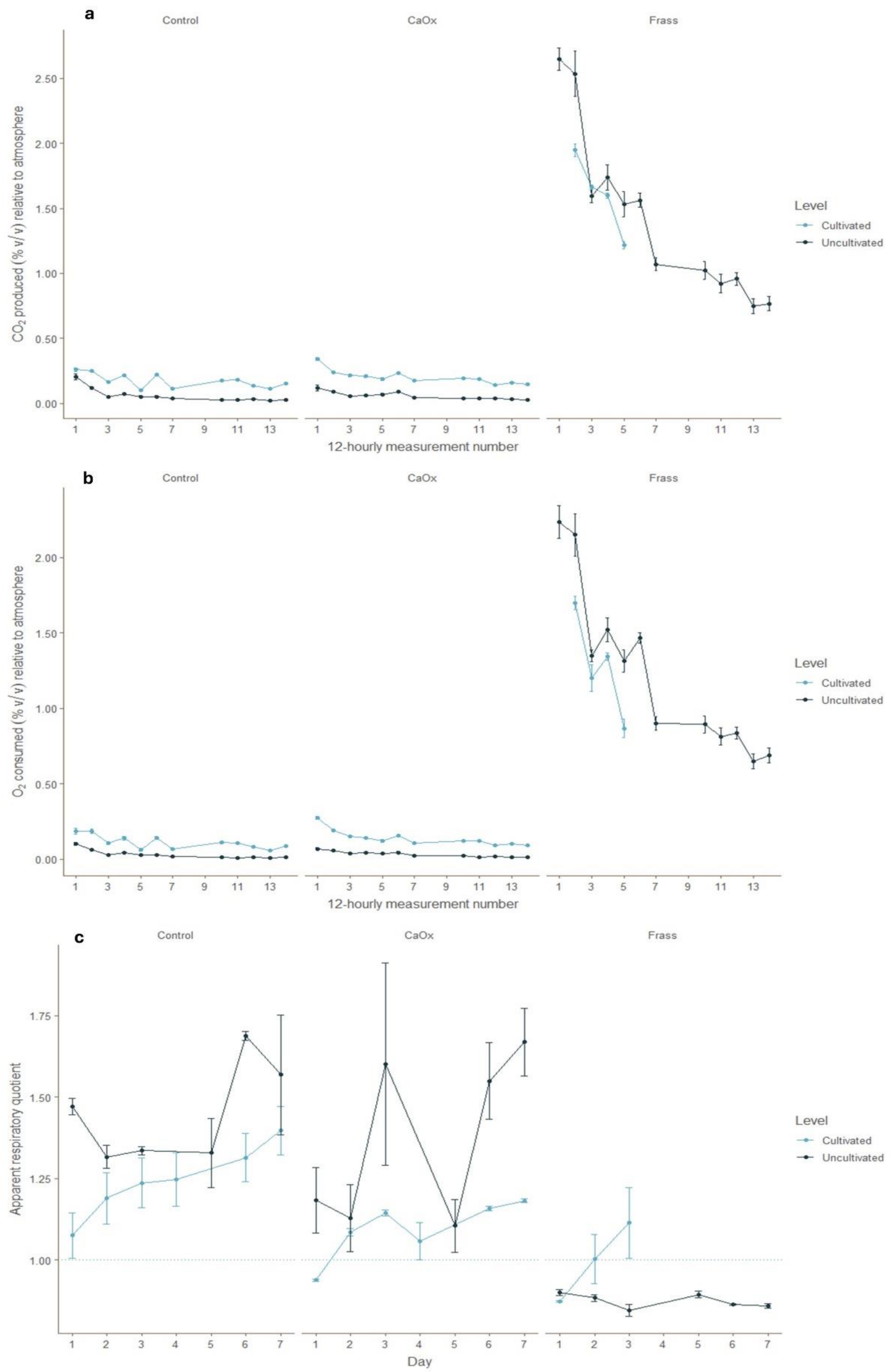

Figure S. 9. Carbon dioxide (CO_2) production (a), oxygen (O_2) consumption (b) and mean apparent respiratory quotient (ARQ) (c) of microcosm soils with different substrate treatments (calcium oxalate i.e., CaOx, termite frass and a control) and disturbance levels (cultivated and uncultivated) at 14 consecutive 12-hourly measurement times or over 7 days. Bars indicate standard error of measurement (SE) for triplicate microcosms (biological replicates).

Supplementary Information Reference List

Citations in Table S. 4, not included in main text reference list.

Coskun, D., Britto, D. T., & Kronzucker, H. J. (2017). The nitrogen–potassium intersection: membranes, metabolism, and mechanism. In Plant Cell and Environment (Vol. 40, Issue 10, pp. 2029–2041). Blackwell Publishing Ltd. https://doi.org/10.1111/pce.12671

Hooper, A. B., & DiSpirito, A. A. (2013). Chemolithotrophy. In Encyclopedia of Biological Chemistry: Second Edition (pp. 486–492). Elsevier Inc. https://doi.org/10.1016/B978-0-12-378630-2.00219-X

McBride, M. B. (1994). Environmental Chemistry of Soils. Oxford University Press.

Swensen, B., & Bakken, L. R. (1998). Nitrification potential and urease activity in a mineral subsoil.

Zheng, Q., Hu, Y., Zhang, S., Noll, L., Böckle, T., Richter, A., & Wanek, W. (2019). Growth explains microbial carbon use efficiency across soils differing in land use and geology. Soil Biology and Biochemistry, 128, 45–55. https://doi.org/10.1016/j.soilbio.2018.10.006