Water uptake patterns of pea and barley responded to drought but not to cropping systems

Author list: Qing Sun[1], Valentin H. Klaus[1], Raphaël Wittwer[2], Yujie Liu[1], Marcel G.A. van der Heijden[2,3], Anna K. Gilgen[1], Nina Buchmann[1]

[1] Institute of Agricultural Sciences, ETH Zurich, 8092 Zurich, Switzerland

[2] Department of Agroecology and Environment, Agroscope, Zurich, Switzerland

[3] Department of Plant and Microbial Biology, University of Zurich, Zurich, Switzerland

Author for correspondence: Qing Sun

Tel: +41 44 632 34 13

Email: qing.sun@usys.ethz.ch; s.qing@outlook.com

Table S1 Stable water isotope values ($\delta^{18}O$ and δ^2H, ‰) of soil in control and drought subplots under different cropping systems (C-IT for Conventional intensive tillage, C-NT for Conventional no tillage, O-IT for Organic intensive tillage, and O-RT for Organic reduced tillage) before the drought treatment (7 May), at the end of treatment (25 June), and after the treatment (11 July) in 2018. Mean ± 1 SE are given. Different small and capital letters indicate significant differences among CS in control and drought subplots, respectively, tested with Tukey HSD (honestly significant difference, $P < 0.05$).

Isotope	Depth (cm)	Control				Drought			
		C-IT	C-NT	O-IT	O-RT	C-IT	C-NT	O-IT	O-RT
Before drought treatment									
$\delta^{18}O$	0-5	-3.6±0.8	-4.6±0.5	-4.8±0.6	-5.1±0.7	-4.8±0.9	-4.7±0.5	-5.6±0.4	-4.2±0.8
	5-10	-4.7±0.8 b	-7.1±1.2 ab	-7.5±0.8 a	-8.2±0.4 a	-7.6±0.7 AB	-8.2±0.3 A	-6.3±1.1 B	-7.7±0.5 AB
	10-20	-6.6±0.6	-8.0±1.4	-9.2±0.5	-8.4±0.5	-7.9±0.8	-8.6±1.2	-7.8±1.0	-8.5±0.5
	20-30	-9.7±0.3 a	-7.8±0.8 b	-9.8±0.2 a	-9.7±0.2 a	-9.8±0.4	-9.8±0.9	-9.6±0.6	-9.6±0.3
	30-40	-10.2±0.3	-10.3±0.2	-9.7±0.5	-9.9±0.3	-10.4±0.1 A	-10.6±0.5 A	-9.6±0.4 B	-10.3±0.2 A
	40-60	-10.3±0.3	-10.2±0.3	-10.3±0.2	-10.5±0.5	-10.3±0.2	-10.5±0.3	-10.2±0.4	-10.4±0.4
δ^2H	0-5	-48.6±3.3	-48.6±1.6	-50.6±3.1	-54.7±3.5	-53.8±2.7	-53.7±1.9	-55.5±2.6	-52.1±2.3
	5-10	-53.4±2.3 b	-62.4±6.5 ab	-65.6±3.7 a	-70.0±1.7 a	-67.6±2.5 AB	-70.8±1.7 A	-60.6±4.6 B	-68.6±2.2 A
	10-20	-63.4±2.0	-68.2±5.8	-72.7±2.3	-70.8±2.8	-69.3±2.7	-72.8±4.5	-69.4±3.5	-71.8±2.2
	20-30	-75.4±1.3 a	-65.0±3.9 b	-73.3±1.7 a	-75.9±1.5 a	-76.7±1.1	-76.7±3.7	-75.5±2.3	-75.9±1.3
	30-40	-76.0±1.5 a	-76.1±0.9 a	-71.8±2.7 b	-75.4±2.4 ab	-79.1±0.3 A	-77.5±1.9 A	-73.2±1.9 B	-77.3±0.9 A
	40-60	-75.5±2.0	-74.2±1.2	-73.9±1.0	-78.4±4.6	-77.9±1.5	-75.6±1.1	-75.9±1.4	-77.4±2.5
End of drought treatment									
$\delta^{18}O$	0-5	-4.7±0.7	-3.1±1.0	-4.7±0.5	-4.5±1.4	-4.0±0.4 B	-3.3±1.1 B	-4.0±0.3 B	-6.4±1.4 A
	5-10	-6.9±0.4	-5.9±1.0	-7.3±0.3	-6.9±0.7	-7.2±0.5	-4.8±1.3	-6.4±0.6	-6.3±1.0
	10-20	-8.9±0.3	-6.6±1.1	-6.8±0.8	-7.7±0.9	-9.0±0.3 A	-6.4±1.0 B	-7.6±1.4 AB	-8.5±0.4 AB
	20-30	-8.3±0.3	-8.2±0.4	-8.0±0.5	-8.2±0.7	-9.6±0.4	-9.5±0.2	-9.7±0.2	-10.0±0.2
	30-40	-9.9±0.2	-9.6±0.4	-9.3±0.4	-9.5±0.4	-10.9±0.1 A	-10.2±0.1 B	-10.7±0.1 A	-10.6±0.2 A
	40-60	-10.9±0.1 a	-10.3±0.2 b	-10.3±0.1 b	-10.2±0.2 b	-11.2±0.1 A	-10.6±0.2 B	-10.7±0.2 AB	-11±0.3 AB
δ^2H	0-5	-47.9±2.7	-40.6±3.9	-45.8±2.1	-47.8±4.5	-52.2±1.4 B	-53.2±4.4 B	-54.8±1.4 B	-62.8±3.8 A
	5-10	-56.8±1.6	-52.6±3.9	-58±1.9	-57.1±2.8	-65.0±1.3	-59.0±3.9	-63.3±2.6	-61.2±3.4
	10-20	-69.0±1.7	-57.3±4.5	-55.9±3.5	-61.5±4.8	-72.0±1.1	-62.9±4.3	-67.9±5.9	-68.9±2.0
	20-30	-65.0±1.9	-64.2±2.4	-61.7±2.8	-63.4±4.7	-75.3±1.7	-75.3±1.1	-75.3±1.1	-77.3±1.1
	30-40	-74.9±1.8	-71.5±2.3	-69.3±2.7	-71.3±3.0	-81.4±0.4 A	-77.6±1.0 B	-80.2±0.6 A	-79.7±1.2 AB
	40-60	-79.8±1.2 a	-76.6±1.2 ab	-75.5±1.5 ab	-75.4±1.8 b	-81.8±0.9 A	-78.2±1.1 B	-79.4±1.4 AB	-81.5±2.4 A
After drought treatment									
$\delta^{18}O$	0-5	-3.8±0.3 ab	-3.5±0.3 b	-4.3±0.1 a	-4.3±0.5 a	-3.4±0.4	-2.2±1.4	-3.7±0.8	-3.6±0.5
	5-10	-4.8±0.5 ab	-5.4±0.3 a	-4.2±0.7 b	-5.3±0.1 a	-5.0±0.4	-4.5±0.5	-5.0±0.3	-4.7±0.5
	10-20	-5.2±0.3	-6.0±0.6	-5.4±0.8	-6.3±0.2	-5.3±0.2	-5.3±0.7	-5.7±0.5	-5.8±0.2
	20-30	-7.1±0.3	-7.5±0.7	-7.3±0.8	-7.2±0.5	-8.1±0.6	-8.2±0.3	-7.6±1.0	-8.2±0.7
	30-40	-9.0±0.3	-9.3±0.3	-8.9±0.4	-9.0±0.5	-9.9±0.8	-9.9±0.3	-9.5±0.3	-9.8±0.6
	40-60	-10.0±0.1	-10.0±0.3	-10.0±0.3	-9.9±0.2	-10.9±0.3	-10.5±0.2	-10.4±0.3	-10.6±0.2
δ^2H	0-5	-36.9±1.5 b	-39.6±1.2 ab	-40.6±0.9 ab	-41.1±2.3 a	-36.6±1.9	-35.4±4.3	-38.1±3.1	-36.4±2.3
	5-10	-41.4±1.3 b	-47.0±1.7 a	-40.9±3.0 b	-43.4±0.5 ab	-41.3±1.6 C	-45.3±1.3 A	-42.9±1.5 BC	-43.0±1.0 B
	10-20	-43.2±1.9	-49.9±3.6	-44.6±4.0	-48.2±1.4	-43.5±1.2	-48.2±3.5	-46.2±2.7	-46.8±1.1
	20-30	-54.0±1.4	-59.6±4.3	-56.4±5.1	-55.1±3.5	-60.5±4.7	-64.3±1.9	-58.3±7.0	-64.2±5.0
	30-40	-67.2±2.3	-70.7±2.3	-67.5±3.0	-67.7±3.5	-74.7±6.4	-74.2±2.5	-71.3±2.2	-75.1±4.7
	40-60	-73.8±1.4	-74.6±1.4	-74.7±1.6	-73.0±1.8	-81.0±1.9	-77.4±1.2	-78.7±1.7	-79.6±1.8

Table S2 Effects of cropping systems (CS, df = 3), drought treatment (D, df = 1) and the interaction (CS × D, df = 3) on stable water isotope data ($\delta^{18}O$ and $\delta^{2}H$, ‰) of pea and barley in control and drought subplots under different cropping systems (C-IT for Conventional intensive tillage, C-NT for Conventional no tillage, O-IT for Organic intensive tillage, and O-RT for Organic reduced tillage) before the drought treatment (7 May), at the end of treatment (25 June), and after the treatment (11 July) in 2018 tested by linear mixed models (*P* values are given). Pea plants were already senesced in early July, therefore no stable water isotope data are available after the treatment. Significant differences are shown in bold ($P < 0.05$). Mean ± 1 SE are given. Different small and capital letters indicate significant differences among different cropping systems in control and drought subplots, respectively, tested with Tukey HSD (honestly significant difference, $P < 0.05$).

Species	Isotope	*P* value from linear mixed models				Mean ± 1 SE							
						Control				Drought			
		CS	D	CS × D	Blocks	C-IT	C-NT	O-IT	O-RT	C-IT	C-NT	O-IT	O-RT
Before drought treatment													
Pea	$\delta^{18}O$	0.449	0.257	0.267	0.652	-7.8±0.3 b	-8.4±0.4ab	-8.6±0.2ab	-8.8±0.3 a	-8.5±0.5	-8.6±0.3	-8.8±0.2	-8.6±0.1
	$\delta^{2}H$	0.334	**0.006**	**0.026**	0.462	-59.2±0.8 b	-64.8±2.4 a	-62.4±0.8ab	-65.4±1.5 a	-65.4±0.5	-65.6±1.3	-65.3±1.2	-64.9±1.6
Barley	$\delta^{18}O$	0.051	0.311	0.377	0.166	-9.7±0.1ab	-9.1±0.1 b	-9.9±0.3 a	-10.1±0.2 a	-9.7±0.3	-9.7±0.2	-10.0±0.2	-10.0±0.1
	$\delta^{2}H$	0.146	**0.026**	0.319	0.926	-72.2±1.0ab	-69.7±1.4 b	-70.8±0.9ab	-73.3±1.3 a	-72.4±0.5BC	-71.7±0.6C	-74.0±0.8 A	-73.9±0.6AB
End of drought treatment													
Pea	$\delta^{18}O$	0.100	**0.022**	0.085	**0.016**	-7.2±0.6	-7.6±0.4	-7.9±0.3	-7.9±0.3	-7.3±0.8 B	-6.0±1.0B	-5.7±1.5 B	-8.3±0.2 A
	$\delta^{2}H$	0.142	0.595	0.074	0.177	-54.9±1.4	-58±1.7	-57.8±1.4	-57.1±2.2	-59.5±3.5 B	-56.3±4.6B	-52.1±4.8 C	-65.1±1.0 A
Barley	$\delta^{18}O$	**0.035**	**0.008**	0.920	**0.008**	-8.4±0.3 b	-8.1±0.4 b	-8.9±0.3 a	-9±0.2 a	-8.9±0.4AB	-8.5±0.4B	-9.1±0.4AB	-9.3±0.2 A
	$\delta^{2}H$	0.174	**<0.001**	0.608	0.357	-65.4±1.3ab	-63.2±1.3 b	-66.2±1.5 a	-66.9±0.6 a	-71.4±0.8	-71.4±1.2	-71.5±0.6	-72.7±0.9
After drought treatment													
Barley	$\delta^{18}O$	0.278	0.473	0.504	**0.019**	-6.1±0.3 b	-6.3±0.3 b	-6.4±0.2ab	-6.8±0.2 a	-6.1±0.7	-6.5±0.7	-5.8±0.2	-6.7±0.3
	$\delta^{2}H$	0.158	0.519	0.557	0.081	-48.6±0.5 b	-52.7±2.1 a	-49.4±1.9ab	-50.9±1.2ab	-50.4±2.9AB	-54.8±4.5A	-47.1±1.0 B	-52.5±2.1AB

Table S3 Effects of cropping systems (CS, df = 3), drought treatment (D, df = 1) and the interaction (CS × D, df = 3) on the median proportional contributions (MPC) from different soil depths to water uptake of pea and barley before the drought treatment (7 May), at the end of treatment (25 June), and after the drought treatment on (11 July) in 2018 tested by linear mixed models. Proportional contributions were derived from 10 000 simulations of mixing models using δ^{18}O data. Pea plants were already senesced in early July, therefore no stable water isotope data are available after the treatment. Proportional contribution from 0-20 cm is the sum from 0-5, 5-10, and 10-20 cm, and 20-40 cm is the sum from 20-30 and 30-40 cm. CS and D were tested as two fixed effect factors for all subplots (*P* values are given). Significant differences are shown in bold ($P < 0.05$). Moreover, mean ± 1 SE for MPC (%) are given for different cropping systems (C-IT for Conventional intensive tillage, C-NT for Conventional no tillage, O-IT for Organic intensive tillage, and O-RT for Organic reduced tillage). Different small and capital letters indicate significant differences among cropping systems in control and drought subplots, respectively, tested with Tukey HSD (honestly significant difference, $P < 0.05$).

Species	Depth (cm)	*P* value from linear mixed models				Mean ± 1 SE							
		CS	D	CS × D	Blocks	Control				Drought			
						C-IT	C-NT	O-IT	O-RT	C-IT	C-NT	O-IT	O-RT
Before drought treatment													
Pea	0-5	0.927	0.749	0.419	0.442	13±3	15±5	18±5	13±3	17±7	19±6	11±4	15±4
	5-10	0.482	0.964	0.663	0.700	14±2	14±2	13±1	15±2	13±2	17±1	11±4	15±1
	10-20	0.499	0.347	0.642	0.461	13±2	12±2	14±2	14±1	13±2 AB	12±2 AB	10±2 A	14±1 B
	20-30	0.113	0.972	0.695	0.093	14±2 b	10±2 a	12±2 ab	15±1 b	13±2	10±1	15±3	14±1
	30-40	0.994	0.434	0.944	0.908	14±2	16±4	15±2	14±2	14±3	13±3	14±2	13±1
	40-60	0.746	0.665	0.216	0.545	16±3	20±8	12±2	13±2	14±3	14±4	26±11	13±1
Barley	0-5	0.275	0.233	0.498	0.073	3±1	6±2	3±1	3±1	8±5	8±3	2±2	3±1
	5-10	0.185	0.493	0.609	0.220	3±1	8±4	5±2	4±2	7±3 AB	10±4 B	3±2 A	4±2 AB
	10-20	0.576	0.700	0.593	0.071	4±1	8±3	8±5	5±2	7±2	10±3	5±3	5±3
	20-30	0.566	0.336	0.516	0.174	10±4	9±3	8±4	8±4	9±3	10±3	28±21	8±4
	30-40	0.897	0.962	**0.009**	0.244	17±6 a	26±7 ab	54±21 b	9±4 a	40±18 B	12±4 A	6±4 A	50±19 B
	40-60	0.940	0.467	0.100	0.634	49±19 ab	31±12 ab	15±7 a	63±17 b	18±6	38±19	49±24	20±8
End of drought treatment													
Pea	0-5	**0.048**	0.098	0.092	0.056	31±11 b	19±8 ab	15±5 a	14±2 a	33±7 AB	12±5 A	52±25 B	17±5 A
	5-10	0.658	0.718	0.958	0.101	16±3	14±3	12±2	16±3	15±2	14±7	10±6	16±2
	10-20	0.596	0.183	0.423	0.231	10±1	10±2	14±2	14±1	11±1	35±22	10±6	25±11
	20-30	0.608	0.077	0.908	0.151	12±2	11±1	11±1	14±2	10±1 AB	10±4 B	7±4 A	10±2 B
	30-40	0.327	**0.003**	0.289	**0.033**	10±2 a	19±7 b	15±3 ab	12±1 ab	8±1 AB	10±4 B	6±3 A	10±2 B
	40-60	0.398	**0.008**	0.272	**0.027**	8±1 a	16±4 ab	18±6 b	14±5 ab	9±1 AB	10±4 B	6±3 A	8±1 AB
Barley	0-5	0.534	0.144	0.413	**0.012**	10±1	10±4	6±1	7±2	12±3	9±1	9±4	12±2
	5-10	0.501	0.348	0.730	**0.028**	12±1	11±3	9±2	9±2	14±3	10±2	11±3	11±4
	10-20	0.063	0.669	0.800	0.178	14±2	11±3	8±2	10±3	14±0 C	10±2 AB	9±2 A	12±1 BC
	20-30	0.865	**0.027**	0.117	0.275	15±1 b	11±2 ab	11±3 a	10±2 a	13±1	16±1	14±3	16±1
	30-40	0.477	0.434	0.844	0.833	16±2	19±4	15±4	14±2	15±3	20±2	21±5	16±2
	40-60	0.207	**0.017**	0.213	**0.028**	15±1 a	23±9 ab	40±13 b	38±13 b	15±2	19±3	24±8	17±3
After drought treatment													
Barley	0-5	0.601	0.508	0.927	0.229	25±10	21±5	19±4	14±2	34±22	22±12	21±7	15±1
	5-10	0.231	0.552	0.414	0.553	13±1	18±3	17±4	16±3	11±4	15±3	31±13	17±3
	10-20	0.422	0.244	0.834	0.193	14±2	15±2	14±2	16±1	11±4 A	12±3 AB	12±2 AB	16±1 B
	20-30	0.709	0.676	0.701	**0.035**	13±2	11±1	13±2	13±1	11±4	12±3	10±3	14±2
	30-40	0.602	0.358	0.596	**0.003**	11±3	11±3	12±3	14±3	10±3	12±4	8±2	12±1
	40-60	0.852	0.401	0.225	**<0.001**	10±2	11±3	13±4	12±3	11±4	13±4	7±2	10±1

Table S4 Effects of cropping systems (CS), drought treatment (D) and the interaction (CS × D) on the median proportional contributions (MPC) from different soil depths to water uptake of pea and barley before the drought treatment (7 May), at the end of treatment (25 June), and after the drought treatment (11 July) in 2018 tested by linear mixed models. Proportional contributions were derived from 10 000 simulations of mixing models using δ^2H data. Pea plants were already senesced in early July, therefore no stable water isotope data were available after the treatment. Proportional contribution from 0-20 cm is the sum from 0-5, 5-10, and 10-20 cm, and 20-40 cm is the sum from 20-30 and 30-40 cm. CS and D were tested as two fixed effect factors for all subplots (*P* values are given). Significant differences are shown in bold ($P < 0.05$). Moreover, mean ± 1 SE for MPC (%) are given for different cropping systems (C-IT for Conventional intensive tillage, C-NT for Conventional no tillage, O-IT for Organic intensive tillage, and O-RT for Organic reduced tillage). Different small and capital letters indicate significant differences among cropping systems in control and drought subplots, respectively, tested with Tukey HSD (honestly significant difference, $P < 0.05$).

Species	Depth (cm)	Linear mixed models				Mean ± 1 SE															
		CS	D	CS × D	Blocks	Control								Drought							
						C-IT		C-NT		O-IT		O-RT		C-IT		C-NT		O-IT		O-RT	
Before drought treatment																					
Pea	0-5	0.794	0.931	0.379	0.675	32±7		29±12		43±9		47±12		39±9		40±7		28±7		42±12	
	5-10	0.260	0.473	0.322	0.851	26±8	b	11±3	a	14±6	ab	11±3	a	15±3		11±2		15±2		12±4	
	10-20	0.828	0.103	0.753	0.312	11±2		9±2		9±1		9±2		12±3		13±4		15±3		11±3	
	20-30	0.385	0.319	0.971	0.080	7±1		9±2		8±1		8±1		8±1		10±1		10±2		8±1	
	30-40	0.345	0.373	0.337	0.400	7±1		22±13		9±1		8±2		7±1	A	8±1	AB	11±2	B	8±2	AB
	40-60	0.417	0.995	0.653	0.500	7±2		11±2		9±1		8±2		8±0		9±1		10±1		8±1	
Barley	0-5	0.281	0.491	0.279	0.154	5±1		10±6		7±1		10±5		15±6	B	16±6	B	4±2	A	6±2	A
	5-10	0.663	0.101	**0.008**	0.425	5±0		7±3		12±3		8±3		11±1	BC	15±2	C	6±3	A	10±3	AB
	10-20	0.774	0.435	0.551	**0.046**	7±1		8±2		11±1		10±3		12±2		10±1		11±5		9±3	
	20-30	0.485	0.561	0.620	0.501	21±4		11±4		15±1		34±22		14±1		11±2		15±6		33±18	
	30-40	0.087	0.114	0.193	0.545	22±5	ab	41±20	b	16±1	a	10±3	a	19±4		16±4		10±4		15±3	
	40-60	0.371	0.514	0.643	0.882	23±5		13±4		21±6		14±7		16±2		16±2		38±21		17±6	
End of drought treatment																					
Pea	0-5	**0.008**	0.054	**0.039**	0.773	55±14	b	27±13	a	23±3	a	27±8	a	68±14	B	22±12	A	84±10	C	25±11	A
	5-10	0.119	0.371	0.291	0.078	10±3		16±4		17±3		16±6		6±3	A	18±8	B	3±2	A	21±8	B
	10-20	0.513	0.376	0.336	0.205	10±5		9±1		17±3		15±6		6±2	AB	36±22	B	5±4	A	31±20	AB
	20-30	0.257	**0.010**	0.412	0.763	7±1	a	12±2	ab	12±1	ab	21±9	b	5±2	AB	6±2	B	2±1	A	6±2	B
	30-40	0.109	**0.002**	0.140	0.079	6±1	a	13±4	b	9±1	ab	6±1	a	5±2	AB	6±2	B	2±1	A	5±1	B
	40-60	0.183	**0.022**	0.386	0.192	5±1	a	12±4	b	7±1	ab	6±2	ab	5±2	AB	7±3	B	2±1	A	5±2	B
Barley	0-5	0.750	0.288	0.107	0.407	14±2		13±6		7±1		9±2		13±1	AB	9±1	A	13±3	AB	15±2	B
	5-10	0.116	0.119	0.618	0.243	15±3	b	10±2	ab	9±1	a	12±2	ab	16±1		10±1		14±2		16±4	
	10-20	0.076	0.081	0.313	0.805	12±1		12±2		9±1		11±2		17±1	B	11±2	A	12±2	A	12±1	A
	20-30	0.889	0.151	0.329	0.389	14±2		13±1		11±1		15±4		14±1	A	17±1	B	16±1	AB	13±1	A
	30-40	**0.028**	0.757	0.685	0.478	13±2		17±3		19±3		12±1		13±1	A	20±2	B	16±2	AB	13±2	A
	40-60	0.396	**0.011**	0.362	0.495	18±6		20±5		34±6		31±9		11±1		17±2		15±2		17±6	
After drought treatment																					
Barley	0-5	0.800	0.387	0.958	0.250	21±2		21±4		21±3		15±2		31±17		26±17		21±6		20±2	
	5-10	0.188	0.999	0.339	0.735	17±2		18±2		20±6		20±4		10±2		11±3		33±14		20±6	
	10-20	0.479	0.134	0.874	0.373	17±1		16±2		16±3		18±2		11±3		13±5		13±3		18±2	
	20-30	0.995	0.279	0.978	0.135	12±1		12±2		12±2		12±2		10±3		11±3		10±3		11±2	
	30-40	0.427	0.894	0.546	**0.039**	10±2		10±2		10±2		8±2		12±4		12±4		6±2		9±1	
	40-60	0.248	0.300	0.260	**0.014**	8±2		8±2		9±2		10±3		10±4	AB	15±5	B	5±1	A	12±4	AB

Table S5 Effects of cropping systems (CS, df = 3), sampling times (Time, df = 1) and the interaction (CS × Time, df = 3) on the median proportional contributions (MPC) from different soil depths to water uptake of pea and barley. Differences in MPC before the drought treatment (7 May) compared to MPC at the end of treatment (25 June) as well as MPC at the end of treatment compared to MPC after the treatment (11 July) for the three soil layers in 2018 tested for control and drought subplots separately by linear mixed models (*P* values are given). Proportional contributions were derived from 10 000 simulations of mixing models using $\delta^{18}O$ data. Pea plants were already senesced in early July, therefore no stable water isotope data are available after treatment. CS and D were tested as two fixed effect factors for all subplots, and CS was tested as fixed factor separately in control or drought subplots. Significant differences are shown in bold ($P < 0.05$).

Species	Type	Control			Drought		
		0-20	20-40	40-60	0-20	20-40	40-60
Before compared to end of drought treatment							
Pea	CS	0.592	0.185	0.418	0.118	0.392	0.216
	Time	0.391	0.406	0.730	**<0.001**	**0.003**	**0.010**
	CS × Time	0.591	0.185	0.418	0.118	0.393	0.217
	Blocks	0.301	0.200	0.516	**0.003**	**0.010**	0.066
Barley	CS	0.429	0.284	0.129	0.242	0.177	0.521
	Time	**<0.001**	0.334	0.212	**<0.001**	0.562	0.084
	CS × Time	0.428	0.285	0.129	0.243	0.177	0.523
	Blocks	0.117	0.821	0.353	**0.008**	0.796	0.177
End compared to after drought treatment							
Barley	CS	**<0.001**	0.246	**<0.001**	**<0.001**	**0.002**	**0.002**
	Time	**<0.001**	0.246	**<0.001**	**<0.001**	**0.002**	**0.002**
	CS × Time	**<0.001**	0.515	**0.004**	**0.001**	**0.006**	**0.008**
	Blocks	**<0.001**	0.681	**0.004**	**0.014**	**0.027**	**0.014**

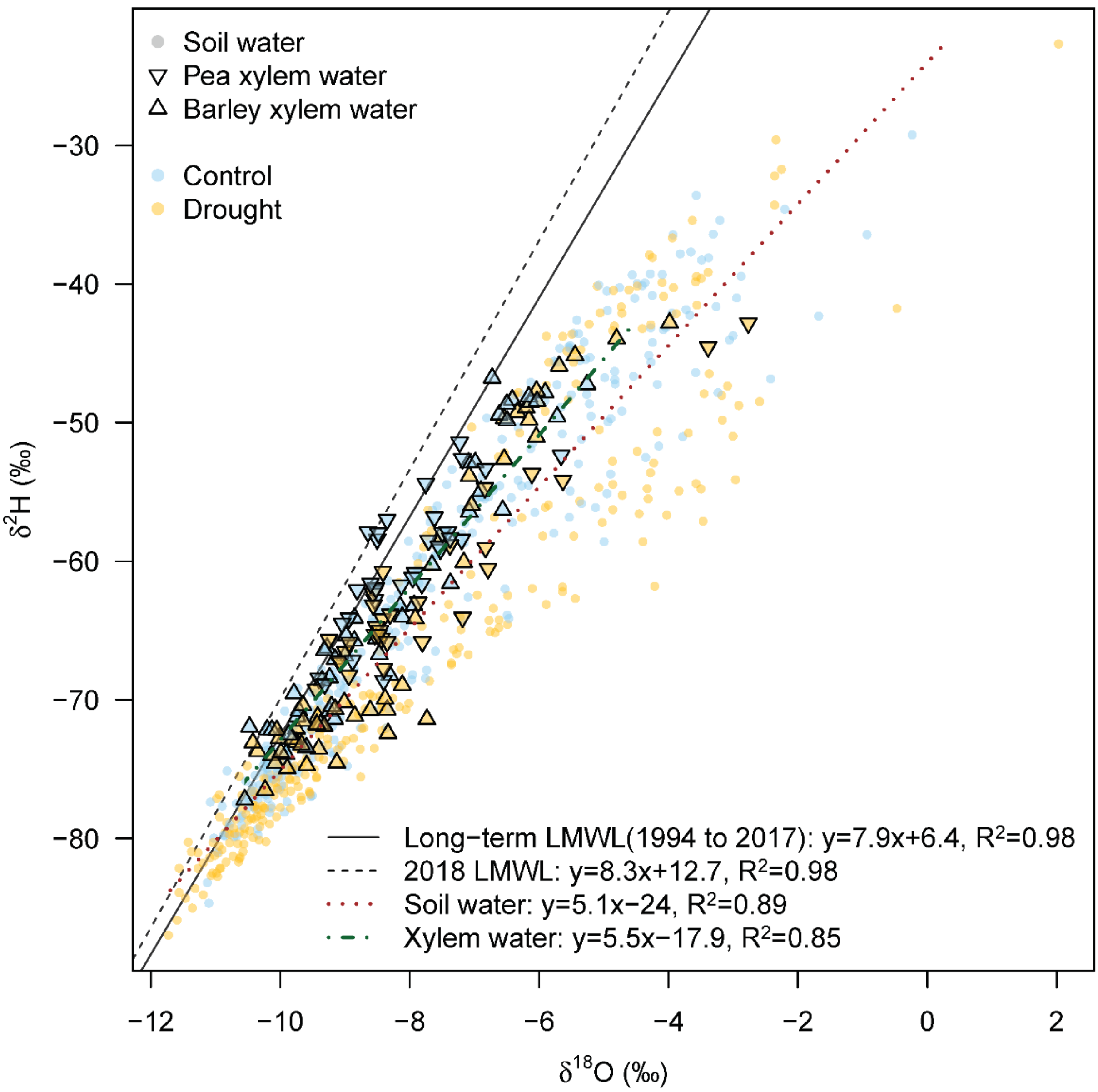

Fig. S1 Dual isotope plot of soil and plant samples from control and drought subplots. The long-term local meteoric water line (LMWL; 1994 to 2017; R^2 = 0.98) was fitted with data from the closest GNIP station (Global Network of Isotopes in Precipitation, Buchs Suhr, 47.37° N, 8.08° E, 34 km from the research site, solid line). The local meteoric water line of 2018 (2018 LMWL; R^2 = 0.98) was fitted with data of precipitation samples collected at the field during the growing season combined with data of 2018 from GNIP Buchs (dashed line). All the precipitation data presented here are monthly means. Regressions for soil water (R^2 = 0.89) and plant xylem water (R^2 = 0.85) were fitted for both treatments together.

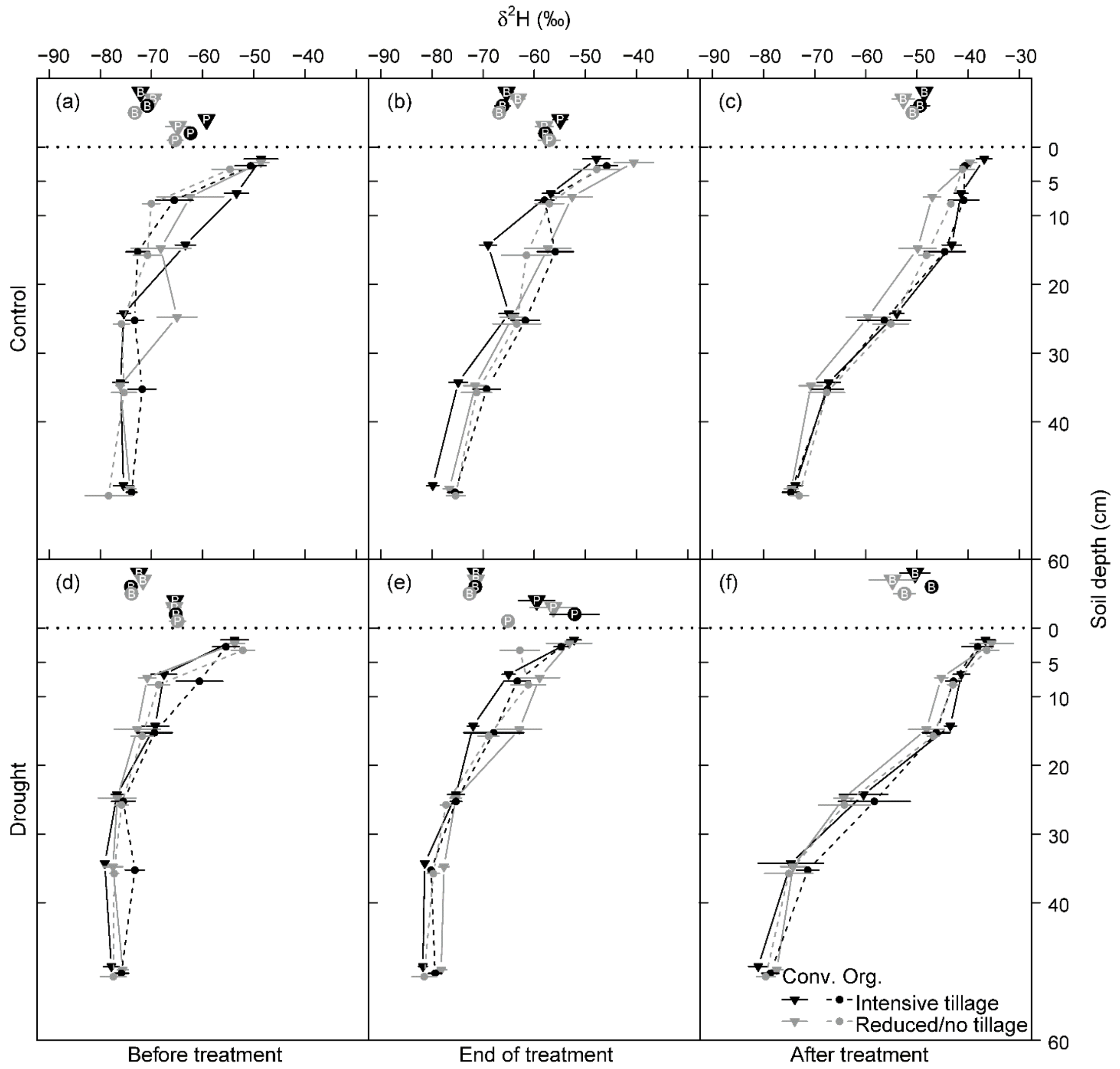

Fig. S2 δ^2H values of soil water from different depths and plant xylem water in each cropping system (a, d) before the drought treatment on 7 May, (b, e) at the end of the drought treatment on 25 June, and (c, f) after treatment on 11 July in 2018 (Conv. for conventional, Org. for organic). Horizontal dotted lines separate isotopic composition of soil and plant samples (P for pea, B for barley). Pea plants were already senesced in early July, therefore no stable water isotope data are available after treatment. Means and 1 SE (horizontal bars) are given of each cropping system (n = 3-4).

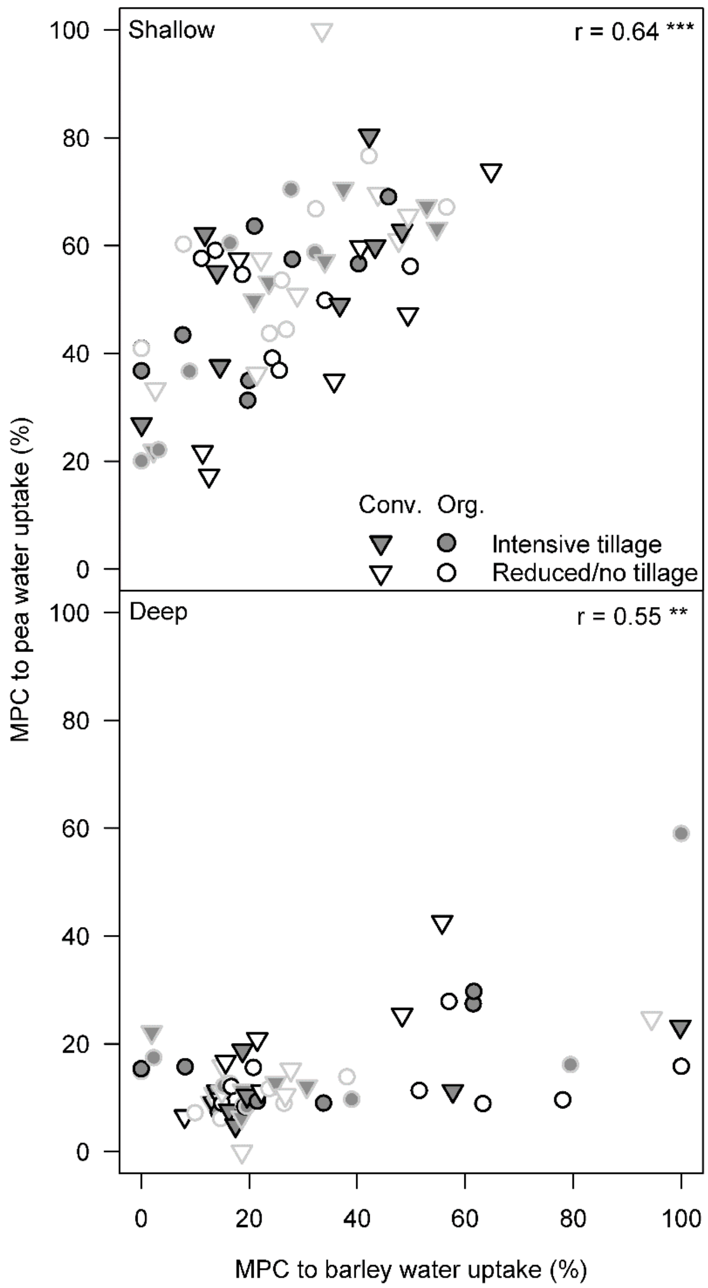

Fig. S3 Relationships of median proportional contributions to plant water uptake (MPC) from the shallow and deep soil layers of pea vs. barley (Conv. for conventional, Org. for organic; n = 29-31). The relationship of MPC from the middle layer (20-40 cm) is not significant (r = 0.2, data not shown). Symbols with dark outlines were from control subplots, those with light outlines from drought subplots. MPC was derived from 10 000 simulations of mixing models using stable water isotope data. Proportional contribution from the shallow layer is the sum of 0-5, 5-10, and 10-20 cm depths and the deep layer represents 40-60 cm. Asterisks indicate the significance of linear regression (*** $P < 0.001$, ** $0.001 \leq P < 0.01$).