

Supplementary information

Title: Negative conspecific plant-soil feedback on alien plants co-growing with natives is partly mitigated by another alien

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This supplementary file includes Figure S1-S3 and Table S1-S6.

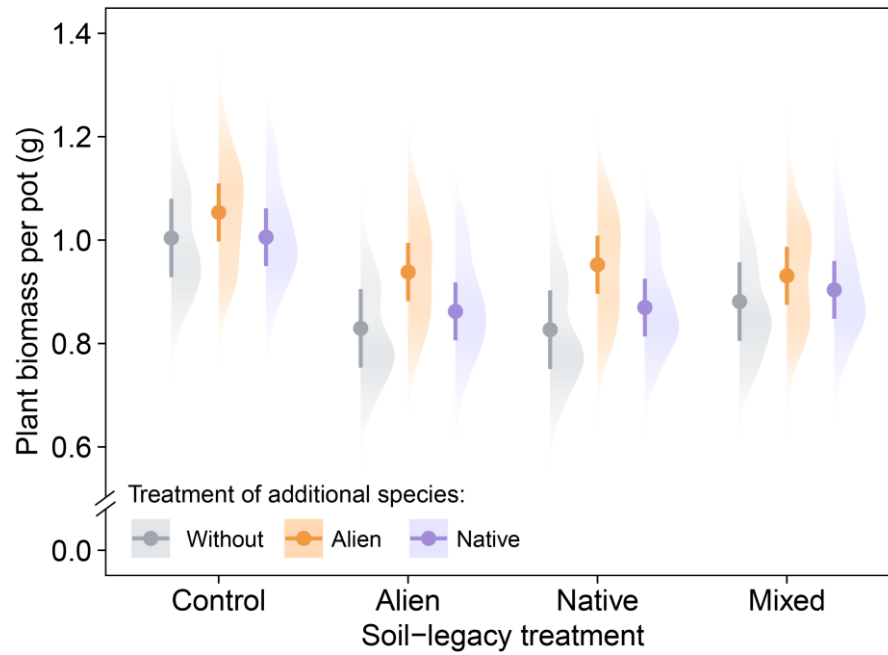


Figure S1 Effects of the presence of an additional alien or native species on the biomass per pot in four soil-legacy treatments. Shown are modelled means ($\pm$ SEs). Density ridgelines indicate the distribution of modelled values.

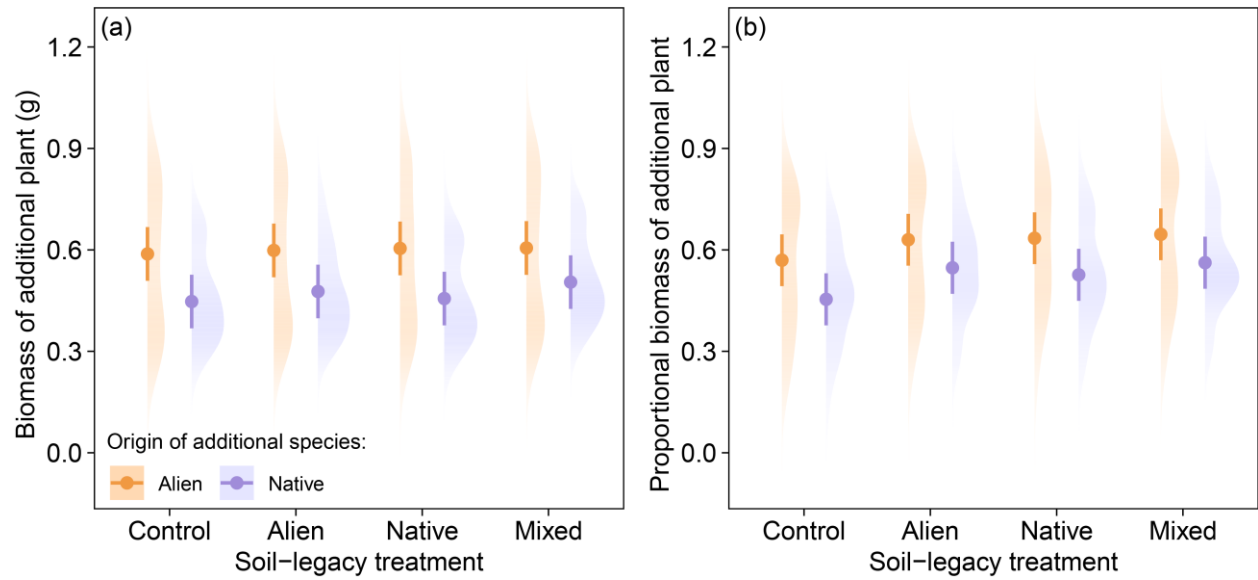


Figure S2 a, Biomass of additional alien and native plants in the four soil-legacy treatments. **b**, Proportional biomass of the additional plant in the four soil-legacy treatments. Shown are modelled means ($\pm$ SEs). Density ridgelines indicate the distribution of modelled values.

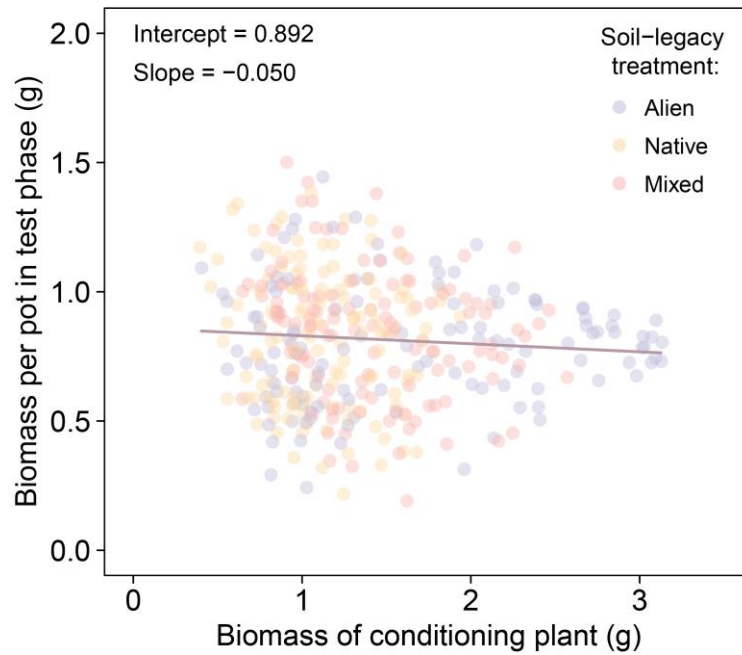


Figure S3 Effects of aboveground biomass of conditioning plants on aboveground biomass per pot in the test phase. Points indicate the average aboveground biomass of the two corresponding conditioning plants from the two pots used for soil mixing, and the line indicates the intercept and slope for the biomass of soil-conditioning plants of the model shown in Table S3. The points are color-coded to indicate the soil-legacy treatments.

Table S1 Plant species used in the experiment.

Species	Family	Origin	Sowing date		Seed source
			Soil-conditioning phase	Test phase	
<i>Bidens frondosa</i> L.	Asteraceae	Alien	21.04.2021	14.07.2021	University of Konstanz, Germany
<i>Lepidium virginicum</i> L.	Brassicaceae	Alien	21.04.2021	12.07.2021	University of Konstanz, Germany
<i>Lolium multiflorum</i> Lam.*	Poaceae	Alien	21.04.2021	12.07.2021	Rieger-Hofmann GmbH, Germany
<i>Solidago canadensis</i> L.	Asteraceae	Alien	12.04.2021	19.07.2021	University of Konstanz, Germany
<i>Bromus sterilis</i> L.	Poaceae	Native	21.04.2021	12.07.2021	University of Konstanz, Germany
<i>Centaurea jacea</i> L.	Asteraceae	Native	12.04.2021	12.07.2021	Rieger-Hofmann GmbH, Germany
<i>Daucus carota</i> L.	Apiaceae	Native	19.04.2021	19.07.2021	Rieger-Hofmann GmbH, Germany
<i>Plantago lanceolata</i> L.	Plantaginaceae	Native	19.04.2021	12.07.2021	University of Konstanz, Germany

* The species is native in part of Europe but alien in Germany.

Table S2 Results of a linear mixed model testing the effects of the presence of an additional species (without, with an alien or with a native), the soil-legacy treatment (Control, Alien, Native or Mixed), and their interactions on aboveground biomass per pot. Values are in bold when $P < 0.05$ and in italic when $0.05 \leq P < 0.1$.

	<i>df</i>	χ^2	<i>P</i>
<i>Fixed effects</i>			
Initial leaf area of all plants per pot	1	5.435	0.020
Additional plant treatment (AP)	2	2.344	0.310
AP _{Without/With}	1	0.739	0.390
AP _{Alien/Native}	1	1.740	0.187
Soil-legacy treatment (SL)	3	117.073	<0.001
SL _{Control/Conditioned}	1	113.635	<0.001
SL _{Mixed/Single}	1	3.952	0.047
SL _{Alien/Native}	1	0.322	0.570
AP $\times$ SL	6	9.078	0.169
AP _{Without/With} $\times$ SL _{Control/Conditioned}	1	2.208	0.137
AP _{Without/With} $\times$ SL _{Mixed/Single}	1	2.400	0.121
AP _{Without/With} $\times$ SL _{Alien/Native}	1	0.194	0.660
AP _{Alien/Native} $\times$ SL _{Control/Conditioned}	1	0.329	0.566
AP _{Alien/Native} $\times$ SL _{Mixed/Single}	1	4.042	0.044
AP _{Alien/Native} $\times$ SL _{Alien/Native}	1	0.048	0.826
<i>Random effects</i>		SD	
Alien test species		0.084	
Native test species		0.037	
Additional species		0.058	
Residual		0.167	

Table S3 Results of a linear mixed model testing the effects the presence of an additional species (without, with an alien or with a native), the soil-legacy treatment (Alien, Native or Mixed), and their interactions on aboveground biomass per pot. The results were analyzed for the subset of data without control pots, and included the aboveground biomass of soil-conditioning plants as a covariate. Values are in bold when $P < 0.05$.

	df	χ^2	P
<i>Fixed effects</i>			
Aboveground biomass of conditioning plants	1	56.900	<0.001
Initial leaf area of all plants per pot	1	4.507	0.034
Additional plant treatment (AP)	2	2.485	0.289
AP _{Without/With}	1	0.809	0.368
AP _{Alien/Native}	1	1.825	0.177
Soil-legacy treatment (SL)	2	9.407	0.009
SL _{Mixed/Single}	1	3.989	0.046
SL _{Alien/Native}	1	5.793	0.016
AP $\times$ SL	4	7.490	0.112
AP _{Without/With} $\times$ SL _{Mixed/Single}	1	5.895	0.015
AP _{Without/With} $\times$ SL _{Alien/Native}	1	0.406	0.524
AP _{Alien/Native} $\times$ SL _{Mixed/Single}	1	0.989	0.320
AP _{Alien/Native} $\times$ SL _{Alien/Native}	1	0.181	0.670
<i>Random effects</i>		SD	
Alien test species		0.090	
Native test species		0.045	
Additional species		0.051	
Residual		0.118	

Table S4 Results of a linear mixed model testing the effects of the origin of the additional species (alien or native), the soil-legacy treatment (Control, Aien, Native or Mixed), and their interactions on the biomass of the additional plant. The results were analyzed for the subset of pots with an additional species. Values are in bold when $P < 0.05$ and in italic when $0.05 \leq P < 0.1$.

	<i>df</i>	χ^2	<i>P</i>
<i>Fixed effects</i>			
Initial leaf area of additional plant	1	25.835	<0.001
Origin of additional plant(OA)	1	1.353	0.245
Soil-legacy treatment (SL)	3	6.530	<i>0.088</i>
SL _{Control/Conditioned}	1	3.663	<i>0.056</i>
SL _{Mixed/Single}	1	2.915	<i>0.088</i>
SL _{Alien/Native}	1	0.320	0.571
OA × SL	3	3.343	0.342
OA × SL _{Control/Conditioned}	1	0.547	0.459
OA × SL _{Mixed/Single}	1	1.976	0.160
OA × SL _{Alien/Native}	1	0.919	0.338
<i>Random effects</i>		SD	
Alien test species		0.054	
Native test species		0.008	
Additional species		0.146	
Residual		0.105	

Table S5 Results of a linear mixed model testing the effects the origin of the additional species (alien or native), the soil-legacy treatment (Control, Alien, Native or Mixed), and their interactions on proportional biomass of the additional plant. The results were analyzed for the subset of pots with an additional species. Values are in bold when $P < 0.05$ and in italic when $0.05 \leq P < 0.1$.

	<i>df</i>	χ^2	<i>P</i>
<i>Fixed effects</i>			
Proportional initial leaf area of additional plant	1	36.624	<0.001
Origin of additional plant (OA)	1	1.194	0.274
Soil-legacy treatment (SL)	3	50.398	<0.001
SL _{Control/Conditioned}	1	48.130	<0.001
SL _{Mixed/Single}	1	3.125	<i>0.077</i>
SL _{Alien/Native}	1	0.213	0.645
OA × SL	3	2.460	0.483
OA × SL _{Control/Conditioned}	1	1.264	0.261
OA × SL _{Mixed/Single}	1	0.296	0.587
OA × SL _{Alien/Native}	1	0.954	0.329
<i>Random effects</i>		SD	
Alien test species		0.091	
Native test species		0.014	
Additional species		0.120	
Residual		0.136	

Table S6 Standard deviations of the alien and native test species, and the additional species in the test phase from the models shown in Tables 1, 2 and S2-S5.

Species	Table 1	Table 2	Table S2	Table S3	Table S4	Table S5
<i>Alien</i>						
<i>Lolium multiflorum</i>	0.124	0.084	0.098	0.090	0.054	0.091
<i>Lepidium virginicum</i>	0.086	0.057	0.172	0.076	0.051	0.082
<i>Solidago canadensis</i>	0.087	0.060	0.130	0.093	0.061	0.078
<i>Bidens frondosa</i>	0.135	0.064	0.139	0.069	0.047	0.088
<i>Native</i>						
<i>Bromus sterilis</i>	0.119	0.037	0.036	0.045	0.008	0.014
<i>Centaurea jacea</i>	0.094	0.030	0.043	0.035	0.008	0.013
<i>Daucus carota</i>	0.094	0.034	0.046	0.041	0.008	0.014
<i>Plantago lanceolata</i>	0.123	0.033	0.048	0.035	0.008	0.015
<i>Additional</i>						
Without	0.032	0.052	0.008	0.053	-	-
<i>Lepidium virginicum</i>	0.036	0.058	0.014	0.051	0.146	0.120
<i>Solidago canadensis</i>	0.029	0.042	0.006	0.047	0.100	0.077
<i>Daucus carota</i>	0.036	0.050	0.010	0.058	0.148	0.111
<i>Plantago lanceolata</i>	0.032	0.044	0.011	0.041	0.140	0.092
<i>Bidens frondosa</i>	0.024	0.047	0.009	0.033	0.143	0.049
<i>Centaurea jacea</i>	0.026	0.041	0.007	0.042	0.106	0.071
<i>Bromus sterilis</i>	0.031	0.063	0.008	0.063	0.169	0.116
<i>Lolium multiflorum</i>	0.028	0.071	0.007	0.062	0.211	0.086