

Initial assemblage characteristics determine the functional dynamics of flower-strip plant communities

Ecology and Evolution

Supporting information

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Appendix S1. Design of species assemblages with contrasting species and functional diversities

Based on the BioFlor trait database (Kühn et al., 2004), we classified plant species into 12 functional groups (Table S1) according to their traits. As we were interested in mixtures enhancing conservation biological control, we focused on traits involved in plant-arthropod interactions, easily accessible in databases: (1) flower resources, i.e. floral and extrafloral nectar or pollen, (2) accessibility of the resource, depending on flower shape, (3) availability of the resource, i.e. the duration of the flowering period and (4) height at flowering. These traits were only used for creating the mixtures, but a larger range of traits has been used for the analyses presented in this study (see Material and Methods).

We constructed the high functional diversity - medium species richness diversity (HFMS) assemblages by choosing species from each of the 12 functional groups identified in Supporting information Table S1. The low functional diversity - medium species richness (LFMS) assemblages were obtained by reducing the number of functional groups to seven and increasing the number of species per group, so as to keep species richness constant. In the HFMS assemblages, we retained only the species of the HFMS assemblages belonging to the most highly contrasting functional groups, to obtain the highest diversity possible. Although the HFMS assemblages contain less functional groups (6) than the LFMS ones (7), the functional groups in the former are more contrasted than in the latter, with very early flowering species (functional group 9), short plant species (functional groups 8 and 9) and with species producing extrafloral nectar (functional group 10). In the HFMS assemblages, we increased species richness and kept functional diversity as constant as possible by adding extra species with trait combinations closely resembling those already present in the HFMS assemblages.

We then added the same three tussock grass species to each assemblage, in similar quantities (Table S2).

Table S1. List of the plant functional groups included in the four types of assemblages (LF and HF mean a low or high functional diversity, LS, MS or HS mean a low, medium or high species richness respectively). Traits values were taken from the BiolFlor (Kühn et al., 2004) and LEDA (Kleyer et al., 2008) trait databases.

Functional group	Flower class after Müller (1881)	Flower type after Kugler (1970)	Month of flowering onset	Month of flowering end	Presence of nectar	Amount of pollen	Extra-floral nectar	Plant height	LFMS	HFMS	LFHS	HFHS
1	flowers with open nectar	disk flowers with nectar open	6-7	9	present	present	none	medium to tall	x	x	x	x
2	flowers with partly hidden nectar	disk flowers with nectar \pm hidden nectaries at base of stamens	4	6	present	present	none	medium to tall	x	x	x	x
3	flower associations with totally hidden nectar	flower heads, Asteraceae, ray and disk flowers	6	9-10	present	present	none	medium to tall	x	x	x	x
4	flowers with open or partly hidden nectar	disk flowers with nectar open or nectar \pm hidden in centre of flower	4-5	6-7	present	present	none	medium to tall	x		x	x
5	flowers with totally hidden nectar	stalk disc flowers, stamina and pistil within tube	5	7	present	present	none	medium to tall	x			x
6	flower associations with totally hidden nectar	flower heads, Asteraceae or non-Asteraceae	7	9-10	present	present	none	tall	x		x	x
7	hymenoptera flowers	flag blossom, Fabaceae type	6	7 to 9	present	present	none	medium to tall	x			x
8	hymenoptera flowers	flag blossom, Fabaceae type or true lip flowers	4-5	6 to 9	present	present	none	low		x	x	x
9	flowers with totally hidden nectar	several types	1 to 3	5	present	present	none	low		x	x	x
10	flower associations with totally hidden nectar or hymenoptera flowers	flower head or flag blossom	5 to 6	7	present	present	present	medium to tall		x	x	x
11	pollen flowers	pollen flowers	5 to 7	8 to 9	none	plenty	none	medium to tall			x	x
12	flowers with partly or totally hidden nectar	disk flowers with nectar \pm hidden	5-6	8 to 9	present	present	none	medium to tall				x

Müller H (1881) Alpenblumen, ihre Befruchtung durch Insekten und ihre Anpassungen an dieselben. W. Engelmann, Leipzig

Kleyer M, Bekker RM, Knevel IC, Bakker JP, Thompson K, Sonnenschein M, Poschlod P, Van Groenendaal JM, *et al.* (2008) The LEDA Traitbase: a database of life-history traits of the Northwest European flora. *Journal of Ecology* 96 (6):1266-1274. doi:10.1111/j.1365-2745.2008.01430.x

Kugler H (1970) Blütenökologie. 2nd edn. Gustav Fischer, Jena,

Kühn, I., Durka, W., Klotz, S., 2004. BiolFlor - a new plant-trait database as a tool for plant invasion ecology. *Diversity and Distributions* 10, 363-365.

Table S2. Origin and perenniality of the sown plant species. Seeds produced by *Ecosem* were produced locally (northern France).

Species	Seed provider	Perenniality	Species	Seed provider	Perenniality
<i>Achillea millefolium</i> L.	Ecosem	Perennial	<i>Hypochaeris radicata</i> L.	Herbiseed	Perennial
<i>Ajuga reptans</i> L.	Phytosem	Perennial	<i>Jacobaea vulgaris</i> L.	Phytosem	Perennial
<i>Alliaria petiolata</i> Cavara&Grande	Herbiseed	Biennial	<i>Knautia arvensis</i> (L.) Coult.	Ecosem	Perennial
<i>Anthriscus sylvestris</i> (L.) Hoffm.	Ecosem	Perennial	<i>Lamium album</i> L.	Herbiseed	Perennial
<i>Arctium minus</i> (Hill) Bernh.	Herbiseed	Perennial	<i>Leucanthemum vulgare</i> Lam.	Ecosem	Perennial
<i>Arrhenatherum elatius</i> (L.) P.Beauv.	Phytosem	Perennial	<i>Lotus corniculatus</i> L.	Ecosem	Perennial
<i>Barbarea vulgaris</i> R. Br.	Ecosem	Biennial	<i>Malva sylvestris</i> L.	Ecosem	Perennial
<i>Bellis perennis</i> L.	Ecosem	Perennial	<i>Medicago lupulina</i> L.	Les semences du Puy	Perennial
<i>Capsella bursa-pastoris</i> (L.) Med.	Phytosem	Annual	<i>Medicago sativa</i> L.	Ecosem	Perennial
<i>Carum carvi</i> L.	Herbiseed	Perennial	<i>Melilotus altissimus</i> Thuill.	Phytosem	Perennial
<i>Centaurea scabiosa</i> L.	Ecosem	Perennial	<i>Onobrychis viciifolia</i> Scop.	Herbiseed	Perennial
<i>Cichorium intybus</i> L.	Ecosem	Biennial	<i>Pastinaca sativa</i> L.	Ecosem	Biennial
<i>Coronilla varia</i> L.	Ecosem	Perennial	<i>Plantago lanceolata</i> L.	Phytosem	Perennial
<i>Cota tinctoria</i> (L.) J.Gay ex Guss.	Phytosem	Biennial	<i>Potentilla reptans</i> L.	Herbiseed	Perennial
<i>Cyanus segetum</i> L.	Phytosem	Annual	<i>Ranunculus repens</i> L.	Phytosem	Perennial
<i>Cynoglossum officinale</i> L.	Les semences du Puy	Biennial	<i>Reseda luteola</i> L.	Ecosem	Perennial
<i>Dactylis glomerata</i> L.	Phytosem	Perennial	<i>Schedonorus arundinaceus</i> Schreb.	Phytosem	Perennial
<i>Daucus carota</i> L.	Ecosem	Biennial	<i>Stellaria media</i> (L.) Vill.	Phytosem	Annual
<i>Echium vulgare</i> L.	Ecosem	Perennial	<i>Tanacetum vulgare</i> L.	Ecosem	Perennial
<i>Euphorbia cyparissias</i> L.	Herbiseed	Perennial	<i>Taraxacum sect. Ruderalia</i> Wiggers	Phytosem	Perennial
<i>Foeniculum vulgare</i> Mill.	Phytosem	Perennial	<i>Trifolium pratense</i> L.	Phytosem	Perennial
<i>Galium mollugo</i> L.	Ecosem	Perennial	<i>Trifolium repens</i> L.	Ecosem	Perennial
<i>Galium odoratum</i> (L.) Scop.	Herbiseed	Perennial	<i>Verbascum densiflorum</i> Bertol.	Les semences du Puy	Biennial
<i>Geum urbanum</i> L.	Herbiseed	Perennial	<i>Verbascum lychnitis</i> L.	Les semences du Puy	Biennial
<i>Glechoma hederacea</i> L.	Les semences du Puy	Perennial	<i>Veronica hederifolia</i> L.	Herbiseed	Annual
<i>Heracleum sphondylium</i> L.	Herbiseed	Perennial	<i>Veronica persica</i> Poir.	Les semences du Puy	Annual
<i>Hesperis matronalis</i> L.	Phytosem	Biennial	<i>Vicia sativa</i> L.	Les semences du Puy	Annual
<i>Hypericum perforatum</i> L.	Arbiotech	Perennial			

Table S3. Effects and 95% confidence intervals of the characteristics of the initial plant assemblages on the temporal dynamics of the composition and diversity of the resulting plant communities over a period of four years. In complement to the results of Table 3, we analysed separately the gradients of initial functional dispersion and species richness. The effect of initial functional dispersion was analysed on a subset of medium species richness assemblages (left panel). The effect of initial richness was analysed on the subset of high functional dispersion assemblages (right panel). Effects whose confidence interval do not encompass zero are in bold. When there was only one best model selected after multimodel inference, we present the results of the analysis of variance of this best model.

Only medium species richness assemblages (LFMS and HFMS)

Response variable: functional dispersion of the whole plant community			
Explanatory fixed variables	Factor levels	Full averaged model	
		Effect	CI
Intercept		0.229	0.206, 0.251
Time		-0.022	-0.029, -0.015
Initial funct. disp. (ref = low)	high	0.032	0.007, 0.057
Initial funct. disp × time (ref = low)	high × time	-0.005	-0.017, 0.006

Marginal R² = 0.46; conditional R² = 0.53

Only high functional dispersion assemblages (HFLS, HFMS and HFHS)

Response variable: functional dispersion of the whole plant community			
Explanatory fixed variables	Factor levels	Analysis of variance	
		Effect	CI
Intercept		0.245	0.221, 0.270
Time		-0.036	-0.044, -0.028
Initial species richness (ref = low)	medium	0.019	-0.014, 0.052
	high	0.013	-0.020, 0.047
Initial sp. richness × time (ref = low)	medium × time	0.011	0.001, 0.035
	high × time	0.023	0.012, 0.035

Marginal R² = 0.62; conditional R² = 0.70

Response variable: standardized effect size of functional dispersion of the whole plant community (calculated with a null model)

Explanatory fixed variables	Factor levels	Analysis of variance	
		Effect	CI
Intercept		-0.686	-1.440, 0.067
Time		-0.309	-0.575, -0.042
Initial funct. dispersion (ref = low)	high	3.078	2.012, 4.144
Initial funct. disp × time (ref = low)	high × time	-0.821	-1.197, -0.444

Marginal R² = 0.53; conditional R² = 0.57

Explanatory fixed variables	Factor levels	Analysis of variance	
		Effect	CI
Intercept		2.683	1.826, 3.528
Time		-1.614	-1.909, -1.315
Initial species richness (ref = low)	medium	-0.267	-1.454, 0.921
	high	-0.715	-1.902, 0.473
Initial sp. richness × time (ref = low)	medium × time	0.479	0.059, 0.899
	high × time	0.872	0.452, 1.292

Marginal R² = 0.64; conditional R² = 0.65

Response variable: species richness of the whole plant community

Explanatory fixed variables	Factor levels	Full averaged model	
		Effect	CI
Intercept		3.500	3.617, 3.681
Time		-0.160	-0.223, -0.097
Initial funct. dispersion (ref = low)	high	-0.097	-0.400, 0.097
Initial funct. disp × time (ref = low)	high × time	0.042	0.006, 0.161

Marginal R² = 0.34; conditional R² = 0.49

Response variable: species richness of the whole plant community

Explanatory fixed variables	Factor levels	Full averaged model	
		Effect	CI
Intercept		3.136	2.999, 3.274
Time		-0.088	-0.124, -0.051
Initial species richness (ref = low)	medium	0.194	0.072, 0.315
	high	0.477	0.359, 0.596
Initial sp. richness × time (ref = low)	medium × time	-0.000	-0.083, 0.079
	high × time	0.003	-0.057, 0.095

Marginal R² = 0.50; conditional R² = 0.59

Table S3. (continued)

Only medium species richness assemblages (LFMS and HFMS)

Response variable: Simpson's species evenness of the whole plant community *

Explanatory fixed variables	Factor levels	Full averaged model	
		Effect	CI
Intercept		0.866	0.769, 0.963
Time		-0.007	-0.061, 0.048
Initial funct. dispersion (ref = low)	high	-0.117	-0.224, -0.010
Initial funct. disp × time (ref = low)	high × time	0.044	-0.006, 0.093

Marginal R² = 0.14; conditional R² = 0.35

Response variable: CWM of LDMC of the whole plant community

Explanatory fixed variables	Factor levels	Full averaged model	
		Effect	CI
Intercept		178.370	165.223, 191.517
Time		12.514	8.051, 16.977
Initial funct. dispersion (ref = low)	high	-8.626	-30.175, 12.924
Initial funct. disp × time (ref = low)	high × time	5.733	-0.216, 11.683

Marginal R² = 0.42; conditional R² = 0.60

* The three lowest values were outliers and were removed to reach normality.

Only high functional dispersion assemblages (HFLS, HFMS and HFHS)

Response variable: Simpson's species evenness of the whole plant community *

Explanatory fixed variables	Factor levels	Full averaged model	
		Effect	CI
Intercept		0.711	0.616, 0.805
Time		0.023	0.004, 0.056
Initial species richness (ref = low)	medium	0.096	0.030, 0.222
	high	0.110	0.010, 0.210
Initial sp. richness × time (ref = low)	medium × time	-0.035	-0.076, -0.013
	high × time	-0.013	-0.053, 0.020

Marginal R² = 0.16; conditional R² = 0.23

Response variable: CWM of LDMC of the whole plant community

Explanatory fixed variables	Factor levels	Analysis of variance	
		Effect	CI
Intercept		173.545	160.406, 186.660
Time		20.193	15.751, 24.636
Initial species richness (ref = low)	medium	-3.916	-22.383, 14.451
	high	2.245	-16.183, 20.644
Initial sp. richness × time (ref = low)	medium × time	-3.779	-8.053, -0.505
	high × time	-9.497	-15.774, -3.216

Marginal R² = 0.58; conditional R² = 0.63

Table S4. Effects of the characteristics of the initial plant assemblages on the temporal dynamics of the standardized functional dispersion (standardized difference between the observed values and values from a null model). As there was only one best model selected after multimodel inference, we present the results of the analysis of variance of this best model. P-values were computed from Wald χ^2 tests. P-values lower than 0.05 are written in bold. In contrast to results of Table 3, time was modeled as a categorical « year » variable to account for the non-linear temporal dynamics of the response variable.

Response variable: standardized functional dispersion						
Explanatory fixed variables	χ^2	df	P ($>\chi^2$)	Factor levels	Effect \pm SE	Significant differences after all pair-wise comparisons
Year (ref = 2014)	410.911	3	$< 10^{-4}$	2015	-1.262 \pm 0.458	2015 < 2014
				2016	-0.849 \pm 0.372	2016 < 2014
				2017	-0.520 \pm 0.373	2017 < 2014
Initial species richness (ref = low)	36.822	2	$< 10^{-4}$	medium	0.010 \pm 0.217	medium > low
				high	0.103 \pm 0.217	high > low
Initial sp. richness \times year (ref = low, 2014)	21.698	6	$1.374 \cdot 10^{-3}$	2015, medium	0.709 \pm 0.374	2016: medium, high > low
				2015, high	0.277 \pm 0.374	
				2016, medium	0.367 \pm 0.304	
				2016, high	0.912 \pm 0.304	2017: high > low, medium
				2017, medium	0.441 \pm 0.304	
Initial funct. dispersion (ref = low)	31.768	1	$< 10^{-4}$	high	2.064 \pm 0.217	high > low
Initial funct. disp \times year (ref = low, 2014)	64.442	3	$< 10^{-4}$	2015, high	-1.386 \pm 0.374	2014: high > low
				2016, high	-1.936 \pm 0.304	
				2017, high	-2.257 \pm 0.304	
Marginal R ² = 0.78; conditional R ² = 0.79						

Table S5. Effects of the characteristics of the initial plant assemblages on the temporal dynamics of the community weighted mean of specific leaf area. Effects whose confidence interval do not encompass zero are in bold.

Response variable: community-weighted mean of SLA for the whole plant community				
Explanatory fixed variables	Factor levels	Effect	z value	CI
Intercept		23.465	26.274	21.715, 25.216
Time		0.747	1.981	0.008, 1.485
Initial species richness (ref = low)	medium	-0.108	0.175	-1.716, 1.360
	high	-0.331	0.647	-1.647, 0.554
Initial sp. richness \times time (ref = low)	medium \times time	-0.023	0.173	-0.987, 0.007
	high \times time	-0.124	0.499	-0.588, 0.406
Initial funct. dispersion (ref = low)	high	0.809	0.968	-0.591, 2.615
Initial funct. disp \times time (ref = low)	high \times time	-0.420	1.197	-1.116, 0.066
Marginal $R^2 = 0.14$; conditional $R^2 = 0.24$				

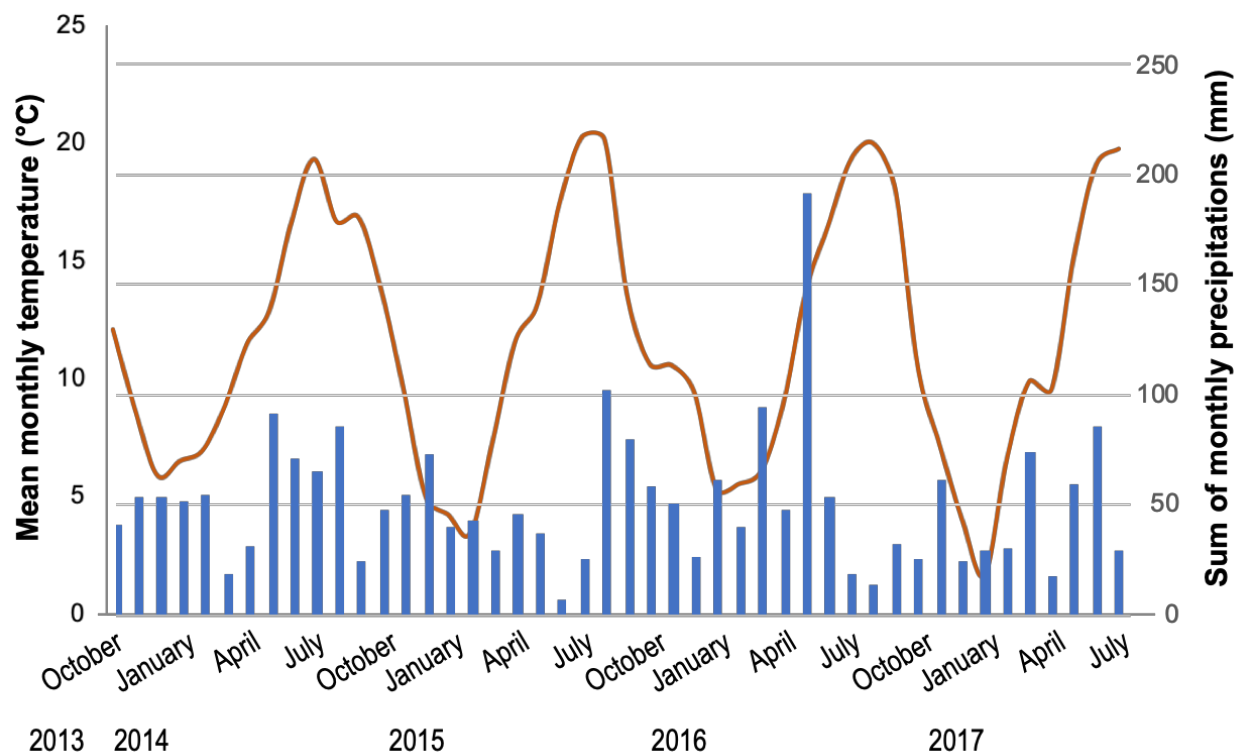


Figure S1. Mean monthly temperature (orange curve, left axis) and monthly precipitations (blue bars, right axis) during the four-year experiment.

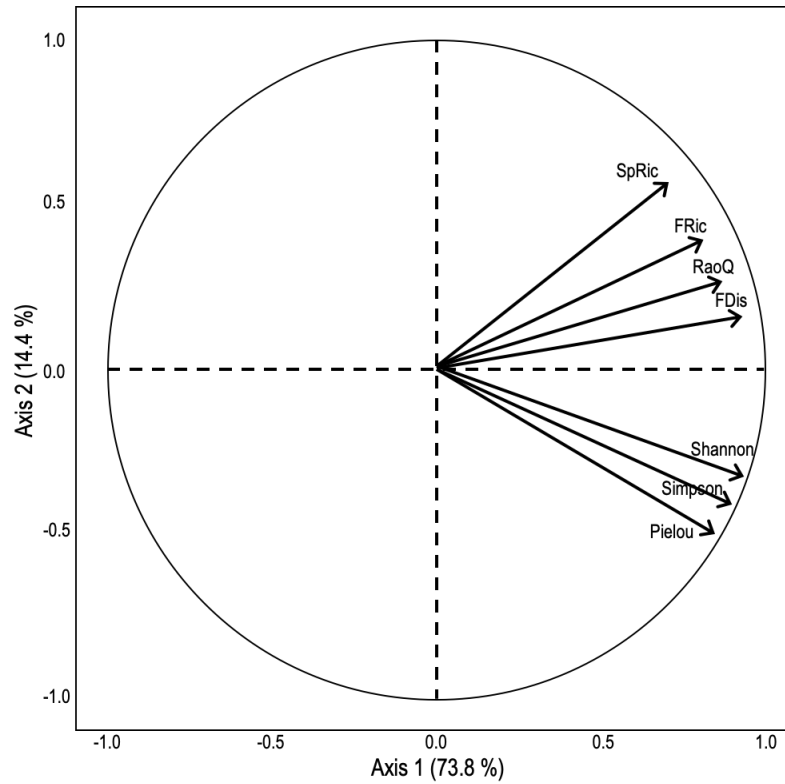


Figure S3. Principal component analysis performed on the observed plant communities during the four-year experiment described by several metrics of taxonomic and functional diversity: species richness (SpRic), Shannon’s species diversity (Shannon), Simpson’s species evenness (Simpson), Pielou’s species evenness index (Pielou), functional dispersion (FDis), functional richness (FRic), and Rao quadratic entropy (RaoQ).

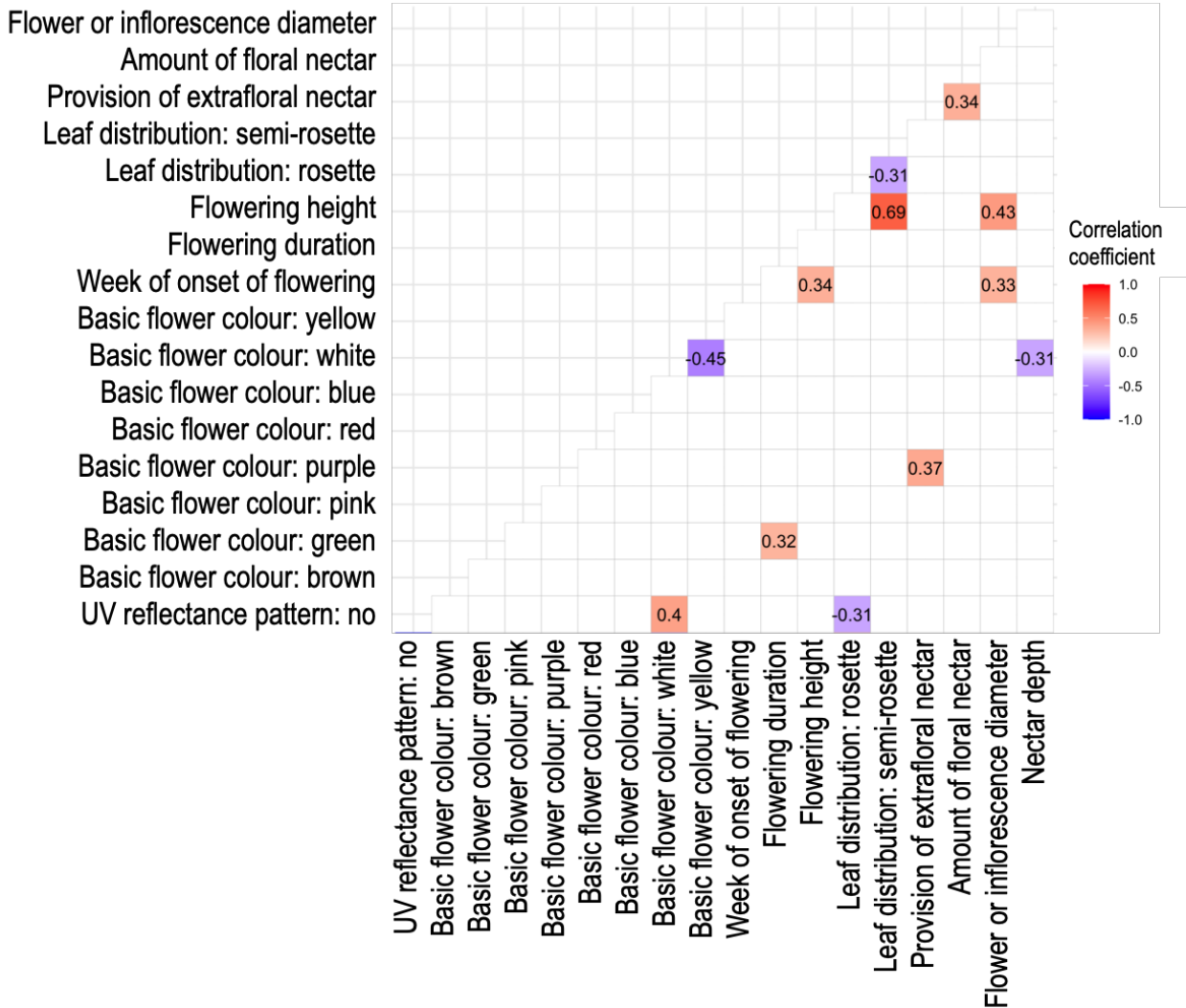


Figure S4. Correlation plot (drawn with the library ggcorrplot under R) between the traits involved in plant-arthropod interactions. Only correlation coefficients significant at $P < 0.05$ are shown. Factor levels were considered as separate variables for categorical traits. We did not interpret correlations between the trait attributes within a single trait (e.g. between colors) which are mutually exclusive.

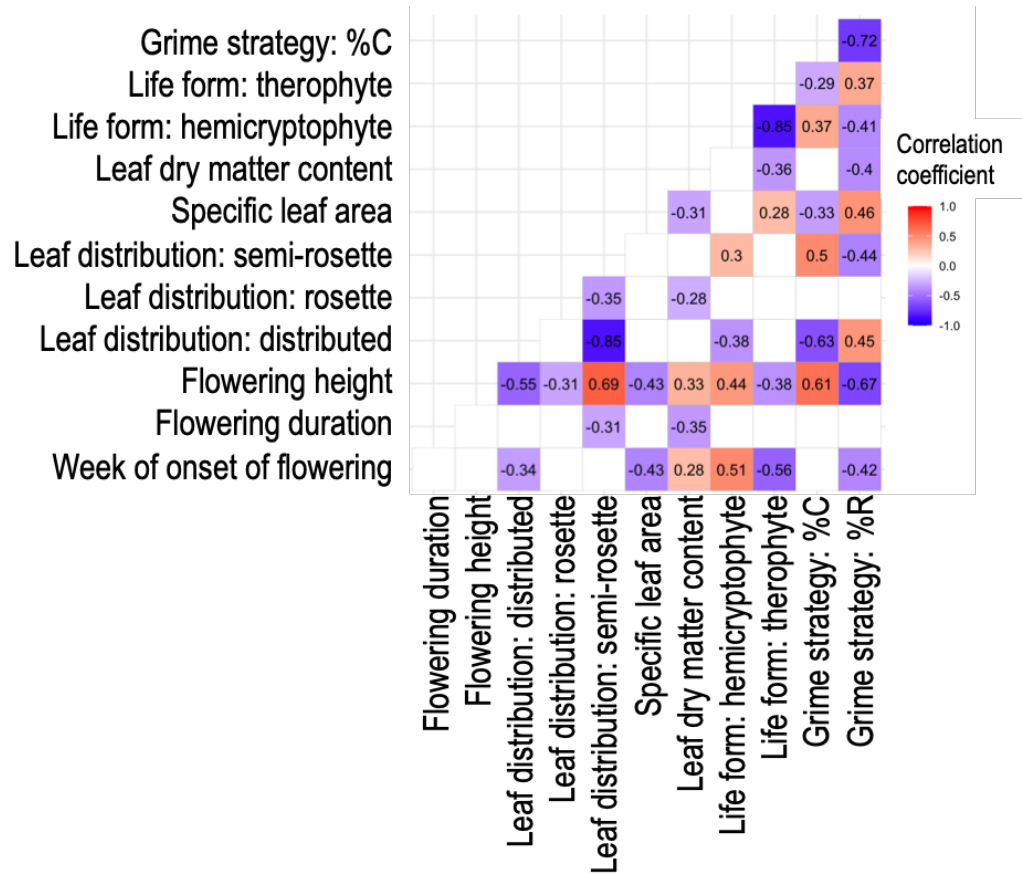


Figure S5. Correlation plot (drawn with the library ggcorrplot under R) between the traits involved in plant-plant interactions. Only correlation coefficients significant at $P < 0.05$ are shown. Factor levels were considered as separate variables for categorical traits. We did not interpret correlations between the trait attributes within a single trait (e.g. between life forms or Grime strategies) which are mutually exclusive.