Supporting Information

Table S1. Collection localities of *Ambrosia artemisiifolia* in the introduced range (East China: CN-1 ~ CN-10) and the native range (United States: US-11~US-20).

Region	Pop code	Populations	Latitude	Longitude	Altitude (m)	Biocontrol history
China	CN-1	Tangqiao	29.356	113.419	80	Yes
	CN-2	Fulin	28.502	115.968	19	Yes
	CN-3	Jingkou	30.299	114.129	61	Yes
	CN-4	Yongjiahe	31.115	114.725	56	Yes
	CN-5	Wuhan	30.540	114.419	27	Yes
	CN-6	Tubuhe	31.255	114.638	49	Yes
	CN-7	Yitang	31.138	113.715	55	Yes
	CN-8	Chengguan	31.276	114.589	48	Yes
	CN-9	Miyun	40.375	116.839	76	No
	CN-10	Shenyang	41.813	123.557	51	No
United States	US-11	Minnesota	46.217	-96.050	364	
	US-12	Alabama	30.675	-87.591	27	
	US-13	Arkansas	33.976	-91.413	51	
	US-14	Florida	30.406	-83.140	20	
	US-15	Kansas	38.686	-96.493	404	
	US-16	Maine	44.771	-68.971	109	
	US-17	Nebraska	40.044	-96.331	428	
	US-18	New York	41.441	-74.529	234	
	US-19	Ohio	40.488	-82.727	349	
	US-20	Pennsylvania	40.966	-78.175	474	

Table S2. Heritability estimation (h^2) of phenotypic trait and plasticity index of *Ambrosia artemisiifolia* populations; bold indicates those significant at $P < 0.05$. H_e and F_{IS} of each populations from both China and the United States is given in the bottom of the table; bold indicates those significant F_{IS} values larger than zero.

Source			China										United States									
			CN-1	CN-2	CN-3	CN-4	CN-5	CN-6	CN-7	CN-8	CN-9	CN-10	US-11	US-12	US-13	US-14	US-15	US-16	US-17	US-18	US-19	US-20
Phenotypic trait	Growth trait	Height	0.36	0.00	**0.69**	0.11	0.20	0.00	0.00	0.06	0.00	0.42	**0.62**	**0.52**	0.51	0.15	**0.60**	0.47	**0.68**	**0.71**	**0.74**	0.01
		Total biomass	0.55	0.16	**0.60**	0.00	0.24	0.31	0.37	0.00	0.38	0.00	**0.58**	0.29	**0.69**	0.00	**0.56**	0.10	**0.63**	0.51	0.46	**0.60**
		Stem biomass	0.56	0.24	**0.60**	0.00	0.20	0.30	0.34	0.06	0.39	0.00	**0.61**	0.32	**0.69**	0.00	**0.52**	0.09	**0.56**	**0.53**	0.44	**0.57**
	Reproduction trait	Flower biomass	0.25	0.00	0.40	0.23	0.21	0.10	0.19	0.00	0.20	0.45	0.00	0.00	0.32	0.00	0.00	0.19	**0.63**	0.29	0.36	0.16
		Flower density	0.45	0.07	**0.64**	0.15	0.35	0.00	0.00	0.00	0.05	0.25	0.42	0.00	0.00	0.00	0.31	0.00	0.50	0.00	0.37	**0.72**
		Flower shoot number	0.23	0.17	0.52	0.01	0.18	0.33	0.40	0.00	0.23	0.48	0.30	0.16	0.00	0.00	0.26	0.50	**0.69**	0.43	0.38	0.40
		Seed status	0.00	0.00	0.95	0.83	0.83	0.00	0.20	0.44	0.00	0.87	0.00	0.00	0.00	0.00	0.57	0.00	0.37	0.00	0.93	0.00
		China vs. US	0.25 ± 0.03 vs. 0.33 ± 0.03; $\chi 2 = 2.92$, P = 0.09																			
Phenotypic Plasticity Index		PI-height	**0.91**	0.57	0.70	**0.79**	**0.85**	0.69	0.83	**0.88**	**0.90**	**0.94**	0.00	**0.77**	**0.83**	**0.82**	**0.95**	0.00	0.00	0.66	0.66	0.98
		PI-Total biomass	**0.88**	**0.85**	**0.82**	0.97	**0.88**	**0.85**	**0.83**	**0.82**	**0.97**	0.77	0.00	0.00	**0.96**	**0.94**	**0.90**	0.29	0.29	**0.79**	**0.89**	0.98
		PI-Flower biomass	**0.98**	0.84	0.54	0.74	0.47	0.00	**0.99**	**0.97**	0.23	0.64	0.00	0.00	0.00	0.34	**0.98**	0.92	0.35	0.00	0.00	**0.87**
		PI-stem biomass	0.88	0.88	0.84	0.66	0.89	0.67	0.72	0.92	0.97	0.72	0.19	0.11	0.42	0.94	0.90	0.00	0.35	0.83	0.90	0.99
		PI-Flower density	0.17	**0.99**	0.77	0.00	**0.92**	**0.94**	0.87	**0.99**	**0.99**	0.61	**0.99**	**0.99**	0.00	0.99	**0.95**	**0.99**	0.88	0.91	0.93	**0.98**
		PI-flower shoot number	0.26	0.00	0.40	0.83	0.48	0.00	0.73	0.54	0.83	0.74	0.29	0.00	**0.99**	**0.99**	0.99	0.79	**0.97**	0.04	0.45	0.77
		China vs. US	0.72 ± 0.04 vs. 0.58 ± 0.05; $\chi 2 = 5.22$, P = 0.02																			
H_e			0.794	0.717	0.718	0.797	0.626	0.748	0.688	0.777	0.688	0.755	0.694	0.754	0.753	0.693	0.794	0.69	0.743	0.721	0.777	0.798
F_{IS}			**0.514**	**0.264**	**0.361**	**0.417**	**0.519**	**0.386**	**0.437**	**0.49**	**0.437**	**0.377**	**0.507**	0.307	0.31	0.213	**0.399**	**0.481**	0.391	0.396	0.218	**0.441**

Table S3. Chi-square and *P*-value of the ML fitted LMMs/GLMMs of the effects of region, populat ion, nutrient treatments and their interactions on eight phenotypic traits and seven phenotypic plasti city indices of *Ambrosia artemisiifolia*.

H: height (cm), TB: total biomass (g), SB: stem biomass (g), FB: flower biomass (g), FD: flower de nsity, FS: flowering shoot number, Seed: seeds status, PI: plasticity index.

Phenotypic traits														
	Growth traits						Reproduction traits						Phenology	
Source	Log(H)		Log(TB)		Log(SB)		Log(FB+0.1)		Log(FD+1)		Log(FS+1)		Seed(Y/N)	
	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P
Range, R	4.21	**0.04**	5.68	**0.02**	5.99	**0.01**	0.3	0.58	0.08	0.79	2.06	0.15	< 0.001	0.1
Populations, P	62.56	**< 0.001**	16.27	0.57	21.28	0.27	45.12	**< 0.001**	37.35	**0.005**	37.78	**0.004**	52.98	**< 0.001**
Nutrient, N	536.35	**< 0.001**	1326.4	**< 0.001**	1382.6	**< 0.001**	79.56	**< 0.001**	2.09	0.15	122.9	**< 0.001**	34.77	**< 0.001**
R × P	0	1	0	1	0	1	0	1	0	1	0	1	0	1
R × N	0	1	0	**< 0.001**	0	1	0	1	0	**< 0.001**	0	1	0	1
P × N	51.95	**< 0.001**	63.68	**< 0.001**	60.49	**< 0.001**	31.78	**0.03**	31.91	**0.03**	34.06	**0.02**	34.93	**0.014**
R × P × N	0	1	0	1	0	1	0	1	0	1	0	1	0	1

Phenotypic plasticity index												
Source	Exp(PI-H)		Exp(PI-TB)		Exp(PI-SB)		Exp(PI-FB)		Exp(PI-FD)		Exp(PI-FS)	
	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P
Range, R	2.72	0.1	5.83	**0.02**	4.32	**0.04**	0.30	0.58	0.004	0.95	0.02	0.90
Populations, P	29.2	**0.05**	22.42	0.21	19.85	0.34	22.17	0.23	43.07	**< 0.001**	17.81	0.47
R × P	0	1	0	1	0	1	0	1	0	1	0	1

Table S4. Variance components and Q_{CT} values for eight phenotypic traits and seven phenotypic plasticity indices calculated for 10 invasive (China) and 10 native (United States) populations of *Ambrosia artemisiifolia*.

Trait			V_{reg}	V_{pop}	V_{dam}	V_{res}	Q_{CT}	2.5% CI	97.5% CI
Phenotypic trait	Growth trait	Height	0.021963	0.041098	0.088222	0.31395	0.09170128	0.0091	0.2117
		TB	0.029513	0.008978	0.198754	0.43858	0.06769089	0.0275	0.1285
		SB	0.036359	0.018452	0.187439	0.43333	0.08461787	0.0304	0.1655
	Reproduction trait	FB	0	0.003374	0.023850	0.211288	0	-0.0251	0.0157
		FD	0	0.054118	0.379730	1.10384	0	-0.0128	0.0095
		FS	0.008973	0.051235	0.411907	0.937227	0.01014977	-0.0190	0.0399
		Seed	0	0.670717	1.058887		0	-0.1120	0.0943
Phenotypic plasticity index		PI-height	0.003025	0.006360	0.228514	0.066881	0.006485614	-0.01	0.0233
		PI-TB	0.011950	0.001000	0.193939	0.04521	0.02981353	0.007	0.0620
		PI-SB	0.005899	0	0.244069	0.221398	0.01193998	-0.0023	0.0287
		PI-FB	0	0.004853	0.746679	0.665715	0	-0.0044	0.0033
		PI-FD	0	0.070363	0.660820	0.28225	0	-0.0099	0.0076
		PI-FS	0	0	0.420052	0.50219	0	-0.0023	0.0018

V_{reg}, variance between regions (China and United States); V_{pop}, variance among populations within regions; V_{dam}, four times the variance among families within populations; V_{res}, residual variance.

Table S5. Chi-square and *P*-value of the ML fitted LMMs/GLMMs of the effects of population, nutrient treatments and their interactions on eight phenotypic traits and seven phenotypic plasticity indices of *Ambrosia artemisiifoli*a in the United States. H: height (cm), TB: total biomass (g), SB: stem biomass (g), FB: flower biomass (g), FD: flower density, FS: flowering shoot number, Seed: seeds status, PI: phenotypic plasticity index.

Phenotypic traits														
	Growth traits						Reproduction traits						Phenology	
Source	Log(H)		Log(TB)		Log(SB)		Log(FB+0.1)		Log(FD+1)		Log(FS+1)		Seed(Y/N)	
	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P
Populations, P	31.90	**< 0.001**	16.71	**0.05**	21.25	**0.01**	27.72	**0.001**	24.10	**0.004**	22.85	**0.007**	32	**< 0.001**
Nutrient, N	163.47	**< 0.001**	501.65	**< 0.001**	524.66	**< 0.001**	42.08	**< 0.001**	2.41	0.12	57.91	**< 0.001**	4.82	**0.03**
P × N	27.37	**0.001**	27.96	**< 0.001**	26.54	**0.002**	23.11	**0.006**	20.21	**0.02**	23.45	**0.005**	11.04	0.27

Phenotypic plasticity index												
Source	Exp(PI-H)		Exp(PI-TB)		Exp(PI-SB)		Exp(PI-FB)		Exp(PI-FD)		Exp(PI-FS)	
	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P
Populations, P	17.03	**0.04**	10.61	0.30	9.44	0.40	10.04	0.35	24.89	**0.003**	7.66	0.56

Table S6. Chi-square and *P*-value of the ML fitted LMMs/GLMMs of the effects of population, nutrient treatments and their interactions on eight phenotypic traits and seven phenotypic plasticity indices of *Ambrosia artemisiifolia* in China. H: height (cm), TB: total biomass (g), SB: stem biomass (g), FB: flower biomass (g), FD: flower density, FS: flowering shoot number, Seed: seeds status, PI: phenotypic plasticity index.

Phenotypic traits														
	Growth traits						Reproduction traits						Phenology	
Source	Log(H)		Log(TB)		Log(SB)		Log(FB+0.1)		Log(FD+1)		Log(FS+1)		Seed(Y/N)	
	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P
Populations, P	18.034	**0.03**	9.20	0.42	8.57	0.48	5.11	0.82	7.48	0.59	9.77	0.37	15.83	0.07
Nutrient, N	484.21	**< 0.001**	887.14	**< 0.001**	916.88	**< 0.001**	37.57	**< 0.001**	0.36	0.55	64.96	**< 0.001**	39.21	**< 0.001**
P × N	9.94	0.36	22.52	**0.007**	21.55	**0.01**	8.61	0.47	11.18	0.26	9.87	0.36	16.51	0.06

Phenotypic plasticity index												
Source	Exp(PI-H)		Exp(PI-TB)		Exp(PI-SB)		Exp(PI-FB)		Exp(PI-FD)		Exp(PI-FS)	
	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P
Populations, P	4.93	0.84	11.51	0.24	10.31	0.33	11.90	0.22	16.34	0.06	9.66	0.38

Table S7. Variance components and Q_{SC} values for eight phenotypic traits and seven phenotypic plasticity indices calculated for 10 populations in each of the native (United States) and invasive (China) ranges of *Ambrosia artemisiifolia*.

Trait			V_{pop}	V_{dam}	V_{res}	Q_{SC}	2.5% CI	97.5% CI
(i) United States								
Phenotypic trait	Growth trait	height	0.080125	0.162949	0.38752	0.1973417	0.0943	0.345
		TB	0.019193	0.361924	0.50190	0.02583041	-0.0338	0.0802
		SB	0.038944	0.330026	0.49876	0.05571467	-0.0529	0.1568
	Reproduction trait	FB	0.122402	0.335284	0.69715	0.154400	0.0634	0.3
		FD	0.141434	0.324535	1.10547	0.1789159	0.0848	0.4109
		FS	0.107622	0.443255	0.96456	0.1082574	0.0406	0.2286
		Seed	1.452124	0		1	0.7020981	1.2979019
Phenotypic plasticity index		PI-height	0.01749	0.297918	0.33188	0.02851729	-0.0438	0.0963
		PI-TB	0.001444	0.335497	0.295670	0.002147342	-0.0344	0.0247
		PI-SB	0	0.3987	0.27978	0	-0.0309	0.0182
		PI-FB	0	0.635391	0.68889	0	-0.1038	0.0738
		PI-FD	0.140073	0.760167	0.1926	0.08436054	0.0163	0.1618
		PI-FS	0	0.561613	0.46076	0	-0.0276	0.0183
(ii) China								
Phenotypic trait	Growth trait	height	0.002474	0.02218	0.226316	0.0528	-0.0489	0.1683
		TB	0	0.056047	0.36601	0	-0.0455	0.0278
		SB	0	0.061591	0.35898	0	-0.0338	0.0208
	Reproduction trait	FB	0	0.184767	0.69794	0	-0.0233	0.0173
		FD	0	0.372816	1.10323	0	-0.0326	0.0211
		FS	0.000131	0.379148	0.913161	0.000172108	-0.0407	0.0231
		Seed	0.036589	2.228612		0.00814219	-0.196742	0.21302711
Phenotypic plasticity index		PI-height	0	0.151685	0.16878	0	-0.0065	0.0049
		PI-TB	0.000427	0.065930	0.091472	0.0032	-0.0223	0.0204
		PI-SB	0.00009	0.10435	0.152524	0.0004	-0.0229	0.0145
		PI-FB	0.013541	0.859019	0.64241	0.0078	-0.0476	0.0521
		PI-FD	0.016889	0.568488	0.34161	0.014600	-0.0281	0.0576
		PI-FS	0	0.325696	0.53542	0	-0.0558	0.0342

V_{pop}, variance among populations; V_{dam}, four times the variance among families within populations; V_{res}, residual variance.

Table S8. Chi-square and P-value of the ML fitted LMMs/GLMMs of the effects of biological control history, population, nutrient treatments and their interactions on eight phenotypic traits and seven phenotypic plasticity indices of invasive Chinese *Ambrosia artemisiifolia* populations. H: height (cm), TB: total biomass (g), SB: stem biomass (g), FB: flower biomass (g), FD: flower density, FS: flowering shoot number, RA: reproductive allocation, Seed: seeds status, PI: phenotypic plasticity index.

Phenotypic traits														
	Growth trait						Reproduction traits						Phenology	
Source	Log(H)		Log(TB)		Log(SB)		Log(FB+0.1)		Log(FD+1)		Log(FS+1)		Seed(Y/N)	
	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P
History, His	0.74	0.39	2.8968	0.08875	0.3845	0.5352	0.05	0.82	0.0783	0.7796	0.0927	0.7608	0.33	0.57
Populations, P	9.98	0.27	1.5192	0.9924	1.405	0.9942	5.10	0.75	9.8377	0.2766	9.3931	0.3102	15.52	**0.05**
Nutrient, N	491.53	**< 0.001**	757.59	**<0.001**	923.66	**<0.001**	37.64	**< 0.001**	2.7379	0.1184	65.244	**<0.001**	39.21	**< 0.001**
His × P	0	1	0	1	0	1	0	1	0	1	0	1	0	1
His × N	0	1	0	1	0	1	0	1	0	1	0	1	0	1
P × N	9.94	0.36	13.393	0.1456	21.553	**0.01**	8.61	0.47	11.887	0.2198	9.8686	0.3612	16.51	0.06
His × P × N	0	1	0	1	0	1	0	1	0	1	0	1	0	1

Phenotypic plasticity index												
Source	Exp(PI-H)		Exp(PI-TB)		Exp(PI-SB)		Exp(PI-FB)		Exp(PI-FD)		Exp(PI-FS)	
	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P
History, His	0.84	0.36	2.01	0.16	2.79	0.09	0.28	0.60	0.02	0.90	3.86	**0.05**
Populations, P	4.09	0.85	9.50	0.30	7.53	0.48	11.63	0.17	16.32	**0.04**	5.63	0.67
His × P	0	1	0	1	0	1	0	1	0	1	0	1

Table S9. Variance components and $Q_{SC\text{-}h}$ values for eight phenotypic traits and seven phenotypic plasticity indices calculated for invasive Chinese *Ambrosia artemisiifolia* populations with vs. without biological control history.

Trait			V_{his}	V_{pop}	V_{dam}	V_{res}	$Q_{SC\text{-}h}$	2.5% CI	97.5% CI
Phenotypic trait	Growth trait	Height	0	0.002474	0.022188	0.226316	0	-0.02132	0.021319
		TB	0.005041	0	0.038489	0.424797	0.0614598	0.0439	0.09386
		SB	0.000633	0	0.060777	0.358985	0.0052	0.0029	0.015
	Reproduction trait	FB	0	0	0.184767	0.69794	0	-0.0627	0.0518416
		FD	0	0.000888	0.217401	0.810011	0	-0.028	0.0154
		FS	0	0.000131	0.379148	0.913161	0	-0.005	0.004
		Seed	0	0.043847	3.712457	0	0	-0.0882	0.0811
Phenotypic plasticity index		PI-height	0	0	0.151685	0.16876	0	-0.009	0.005
		PI-TB	0.000804	0.000140	0.65930	0.091484	0.0061	0.0019	0.0172
		PI-SB	0.00259	0	0.10131	0.152565	0.0126196	0.0029	0.0274
		PI-FB	0	0.013541	0.859019	0.64241	0	-0.0073	0.0035
		PI-FD	0	0.016889	0.568488	0.34161	0	-0.0541	0.0016
		PI-FS	0.030845	0	0.28456	0.53622	0.0514119	0.0258	0.0788

V_{reg}, variance between regions (China and United States); V_{pop}, variance among populations within regions; V_{dam}, four times the variance among families within populations; V_{res}, residual variance.

Figure S1

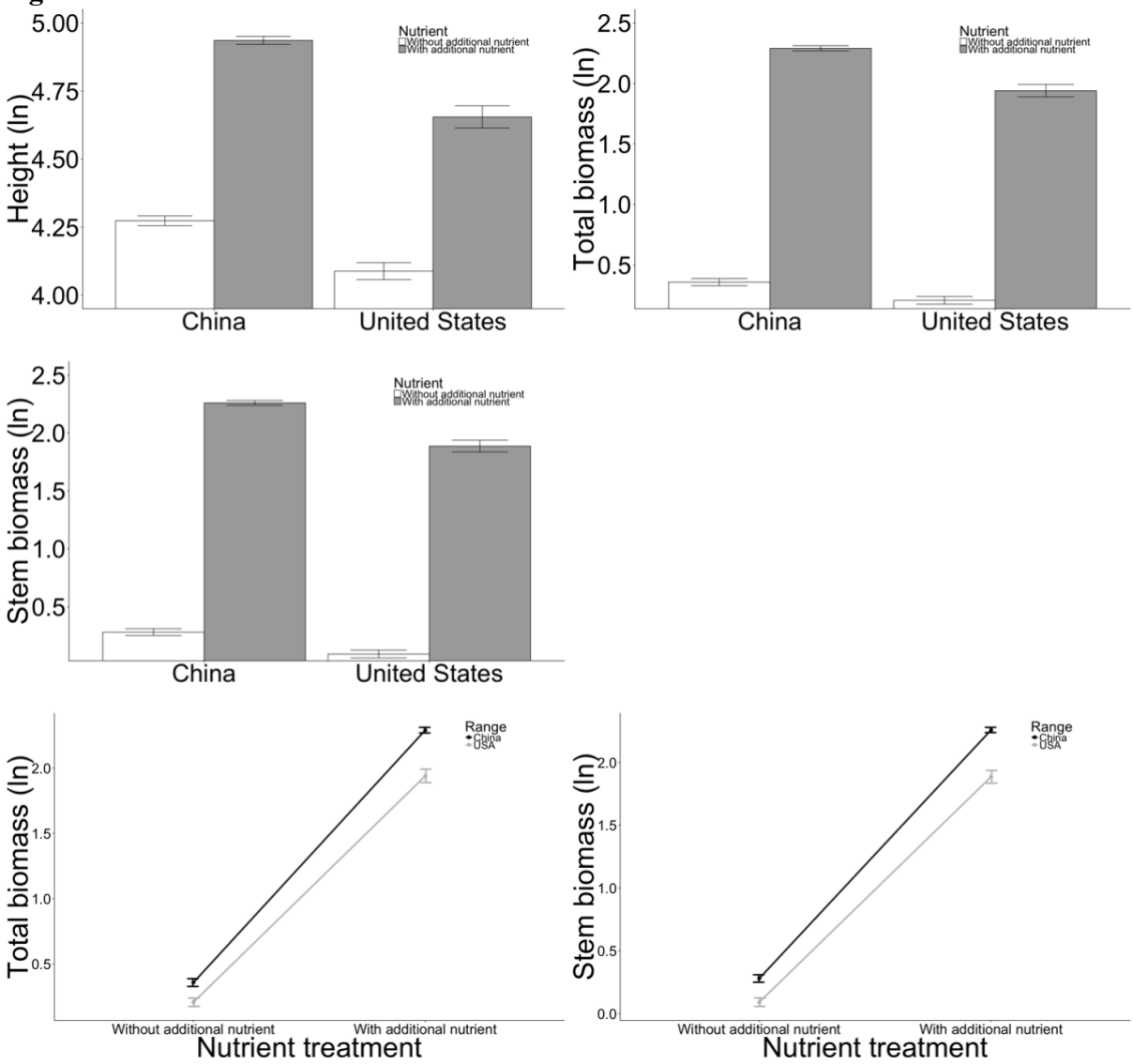

Fig. S1. Comparison between invasive China populations with native United States populations of *Ambrosia artemisiifolia* under control and rich nutrient conditions for three phenotypic traits and two phenotypic plasticity indices that showed significant $Q_{CT} > F_{CT}$; lower panels show phenotypic plasticity in response to nutrient addition between the two ranges; error bars represent ±SE. All data are ln-transformed.

Figure S2

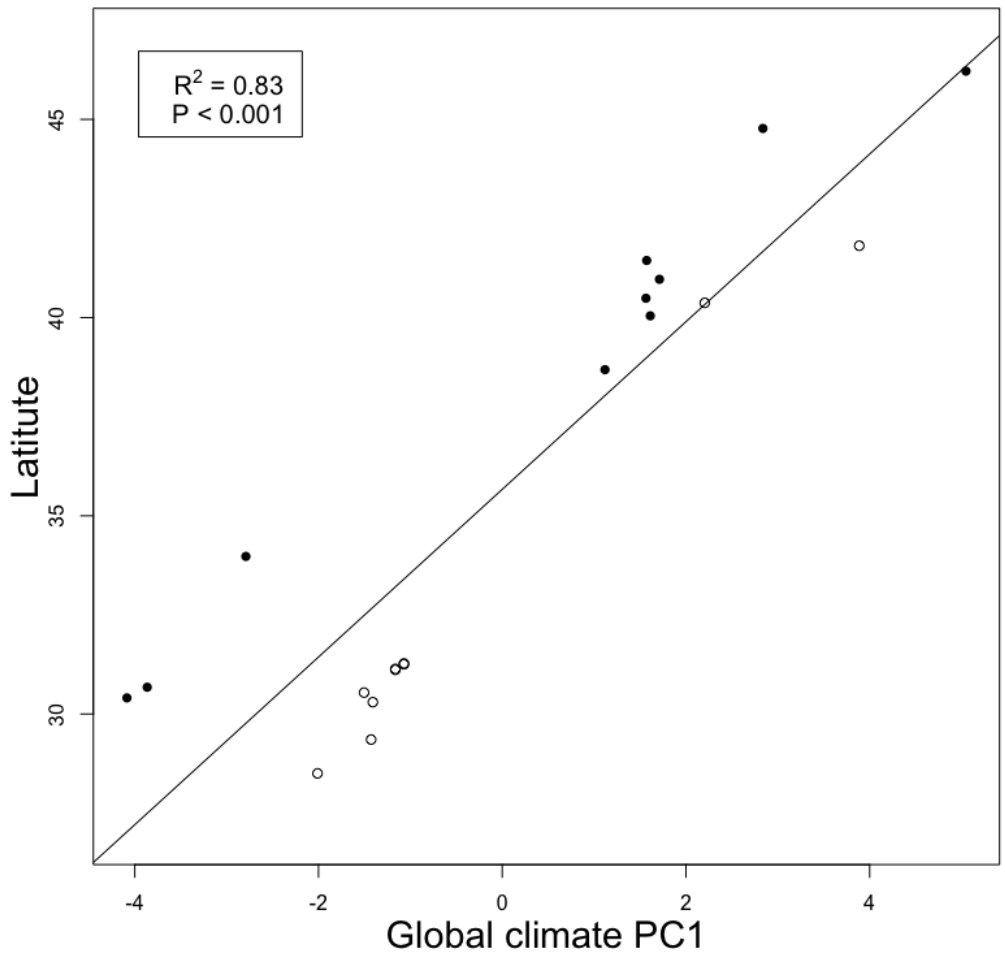

Fig. S2. Relationship between climate and latitude of all *Ambrosia artemisiifolia* populations from both China (open circles) and United States (solid circle).

Figure S3

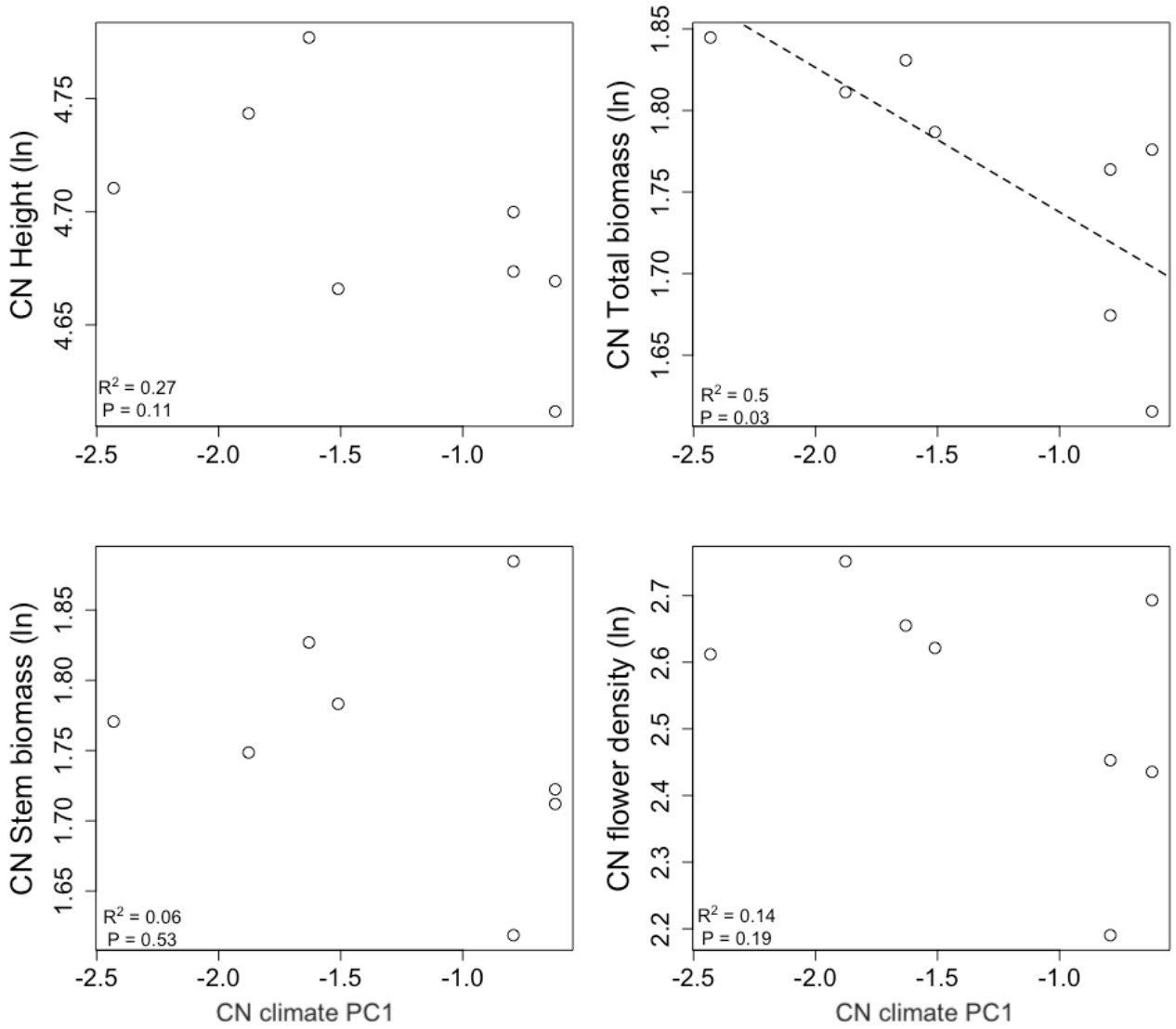

Fig. S3. Relationship between climate and traits of *Ambrosia artemisiifolia* from Chinese (CN) populations with biocontrol history (subset of all CN populations in Fig. 4). Negative values for CN Climate PC1 indicate less seasonality and warmer summers.

Figure S4

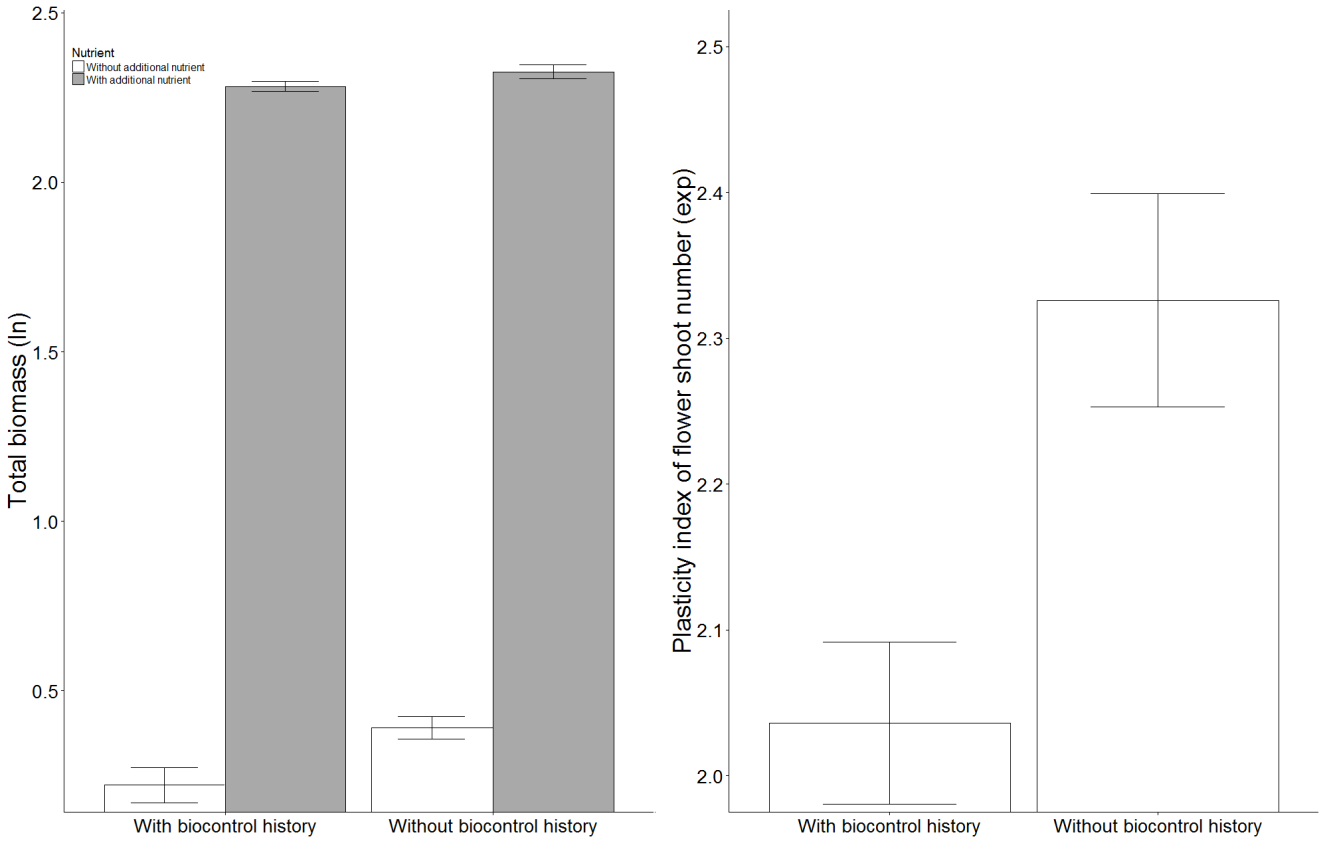

Fig. S4. Total biomass (gram, left) and plasticity index of flower shoot number in response to nutrient addition (right) for invasive Chinese *Ambrosia artemisiifolia* populations with different biological control histories. The traits of total biomass also showed significant $Q_{SC\text{-}h} > F_{SC\text{-}h}$ (Fig. 5); error bars represent the ±SE. All data were transformed.

Figure S5

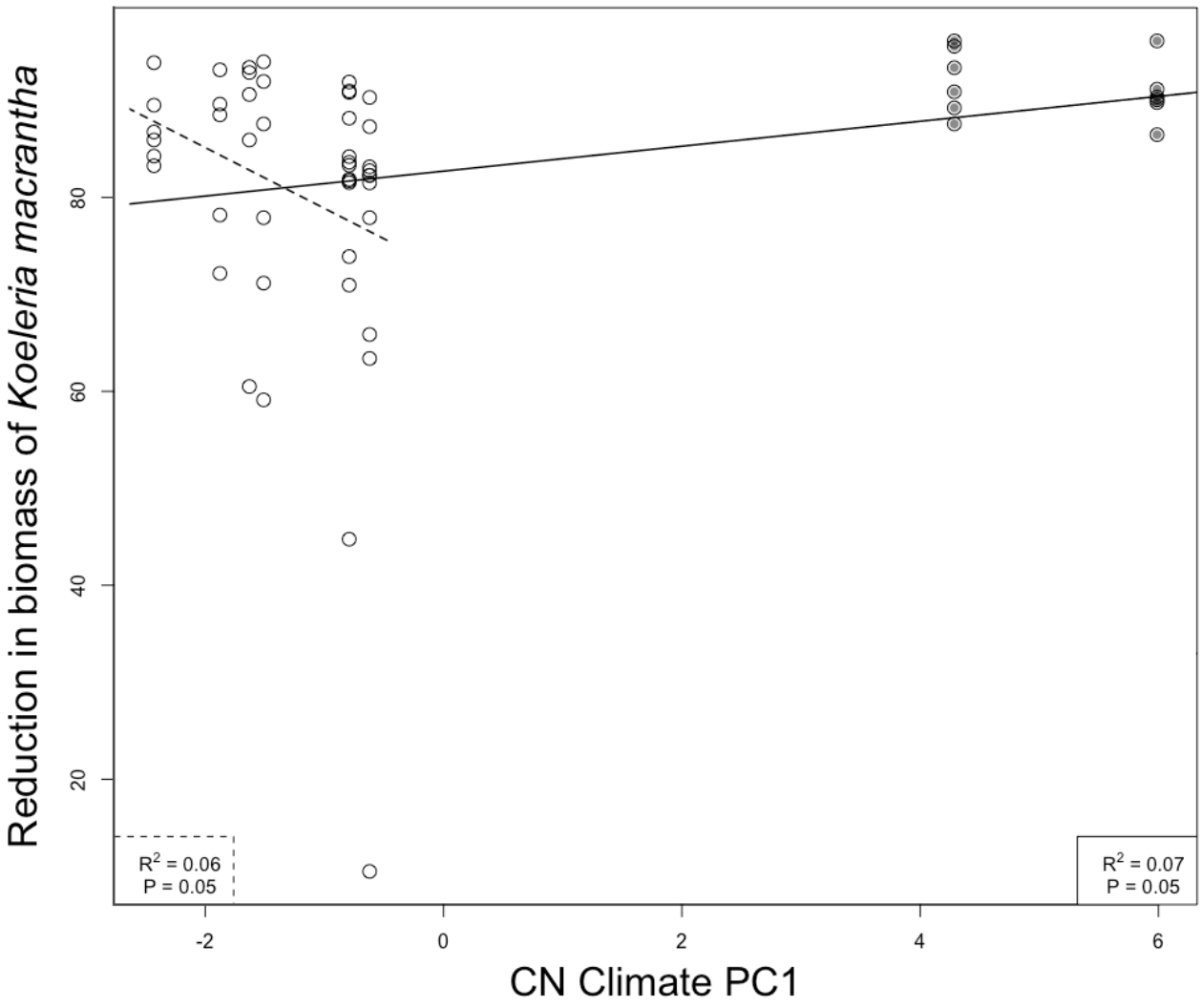

Fig. S5. Relationship between China climate (CN Climate PC1) and reduction in biomass of *Koeleria macrantha*, regression showed in solid line. Negative values for CN Climate PC1 indicate less seasonality and warmer summers (lower latitude). Open points and dashed line indicate the regression of reduction in biomass of *K. macrantha* when in competition with CN *Ambrosia artemisiifolia* populations with biological control history and grey points indicate those in competition with CN populations without biological control history.