

Supplemental Materials

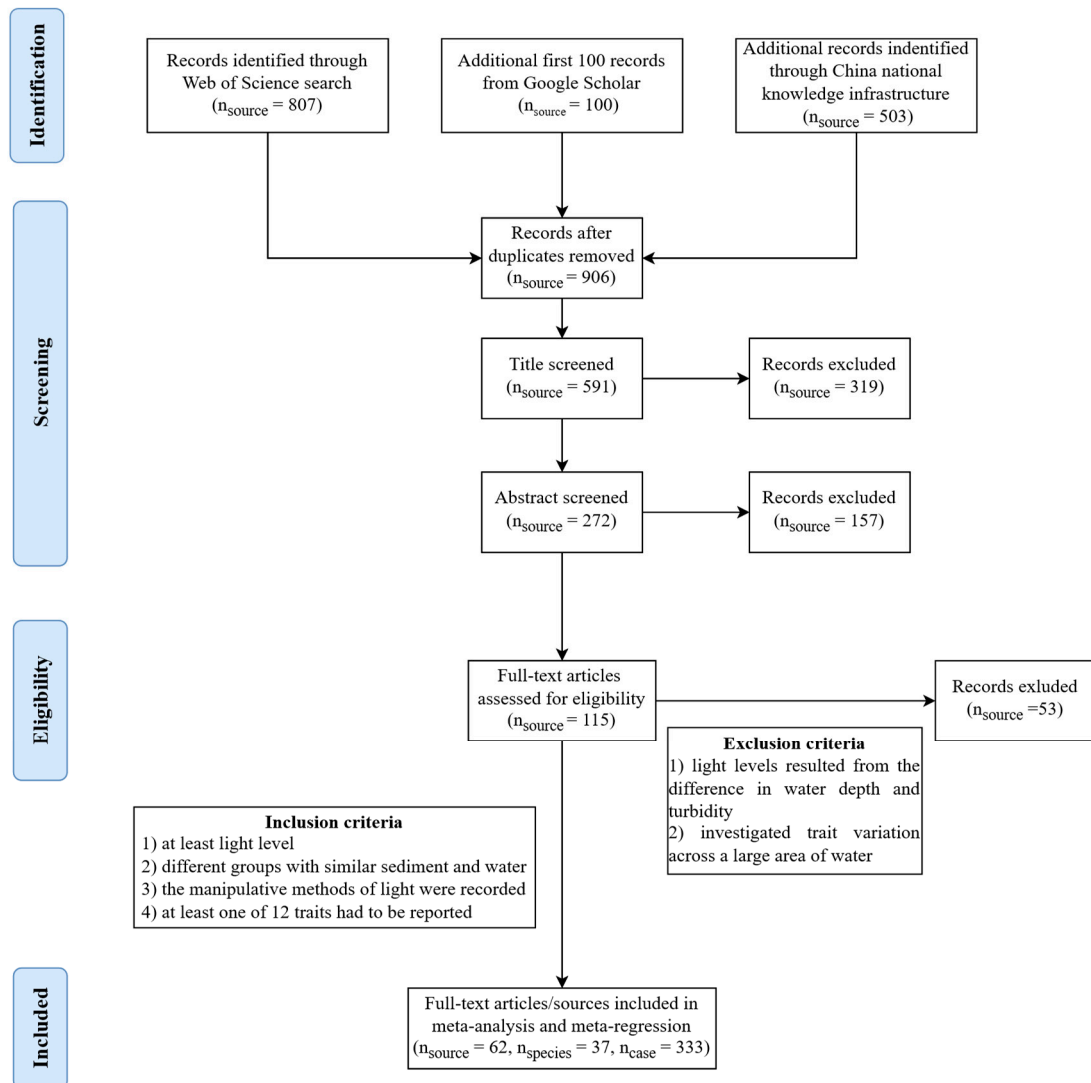


Figure S1 PRISMA flow chart showing the process of selecting publications.

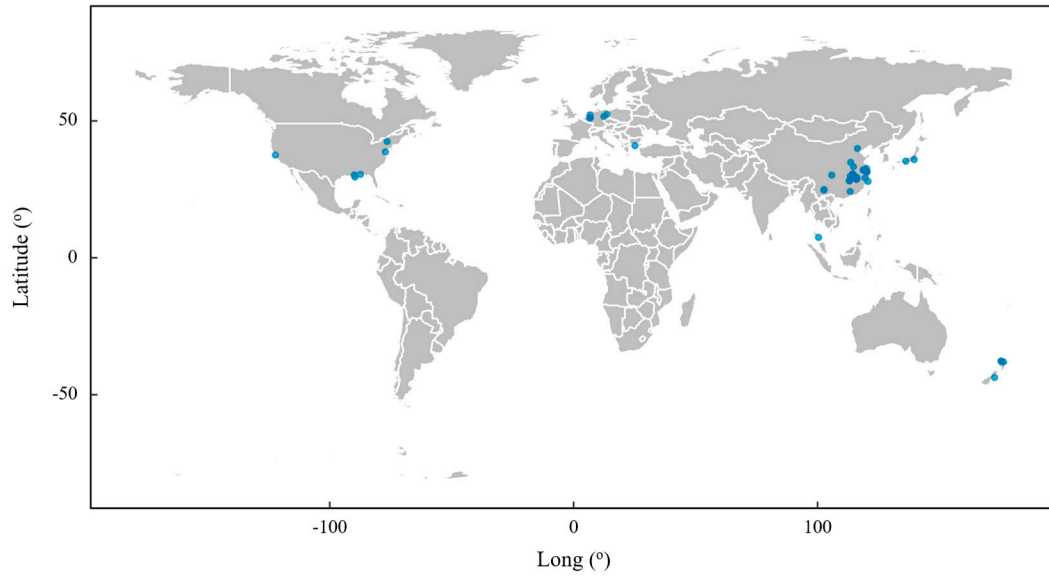


Figure S2 Geographical distribution of sampling sites of submerged plants in the study cases included in the meta-analysis.

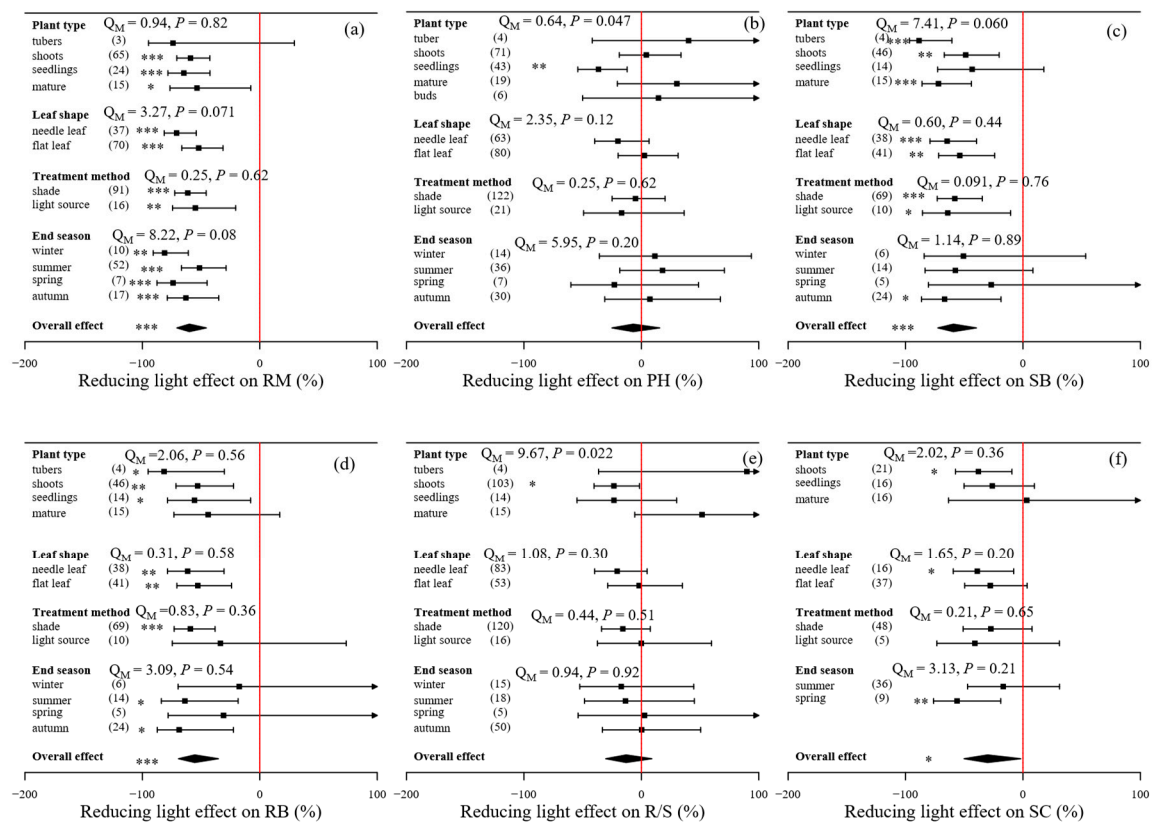


Figure S3 Meta-analysis of the effects of light reduction on the whole-plant traits across different moderators. RM: ramet number, PH: plant height, SB: shoot biomass, RB: root biomass, R/S: root-to-shoot ratio, SC: soluble carbohydrates. Overall effect and 95% confidence intervals of light reduction on each trait are given. Where the zero line (red solid line) is not crossed by the confidence intervals, the effect of light reduction was significant (shown by the asterisks, * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$). Arrows indicate 95% confidence intervals extending beyond the limits of the plot. Values in parentheses are sample sizes. The effects of moderators are tested by Q_M at the 0.05 level.

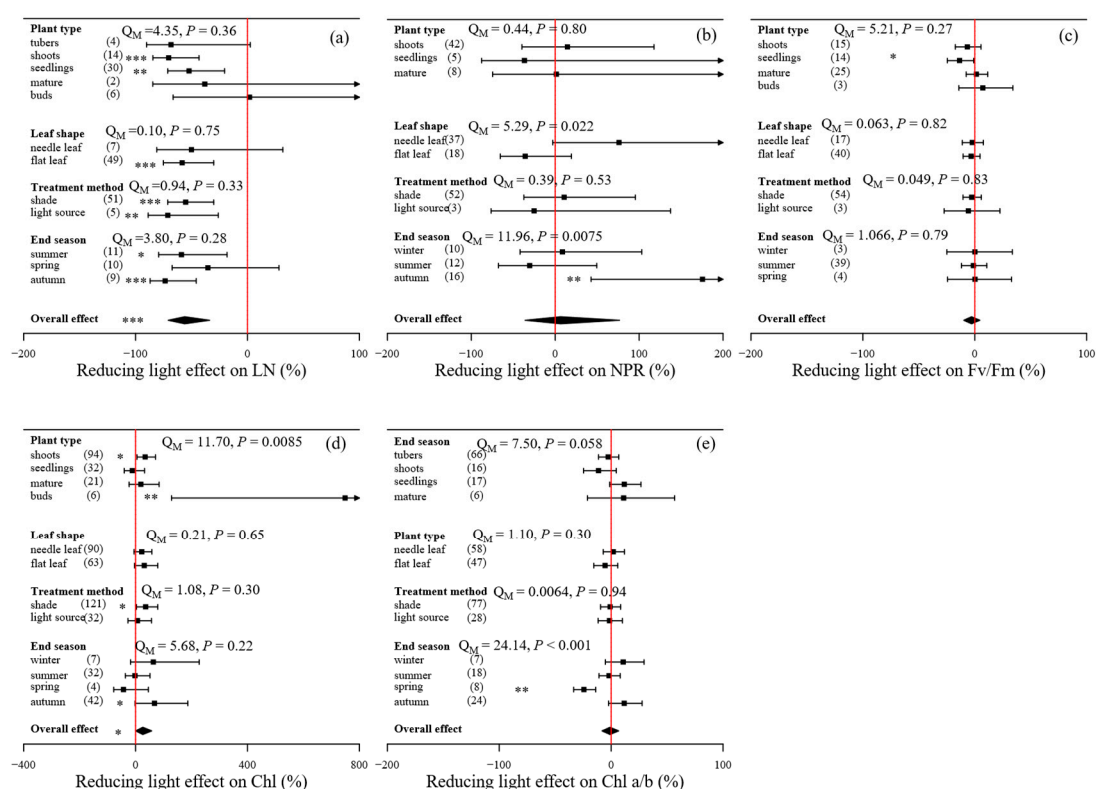


Figure S4 Meta-analysis of the effects of light reduction on the leaf traits across different plant moderators. LN: leaf number, NPR: net photosynthesis rate, Fv/Fm:

leaf maximal quantum yield of photosystem II complex, Chl: chlorophyll content, Chl a/b: chlorophyll a/b ratio. Overall effect and 95% confidence intervals of light reduction on each trait are given. Where the zero line (red solid line) is not crossed by the confidence intervals, the effect of light reduction was significant (shown by the asterisks, * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$). Arrows indicate 95% confidence intervals extending beyond the limits of the plot. Values in parentheses are sample sizes. The effects of moderators are tested by Q_M at the 0.05 level.

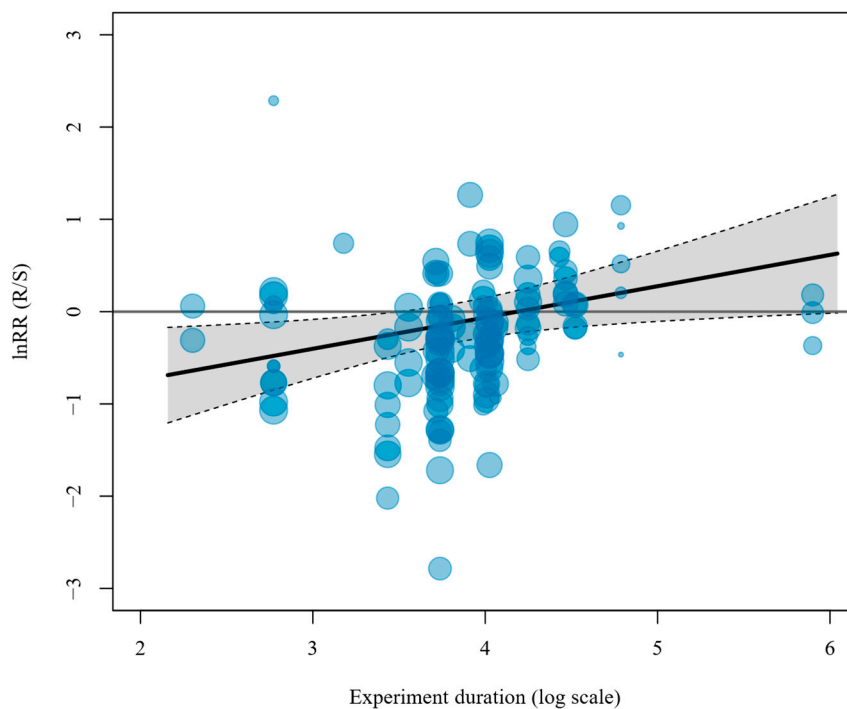


Figure S5 Relationship of lnRRs of submerged macrophytes root-to-shoot ratio (R/S) with the experimental period (log scale) in the meta-analysis.

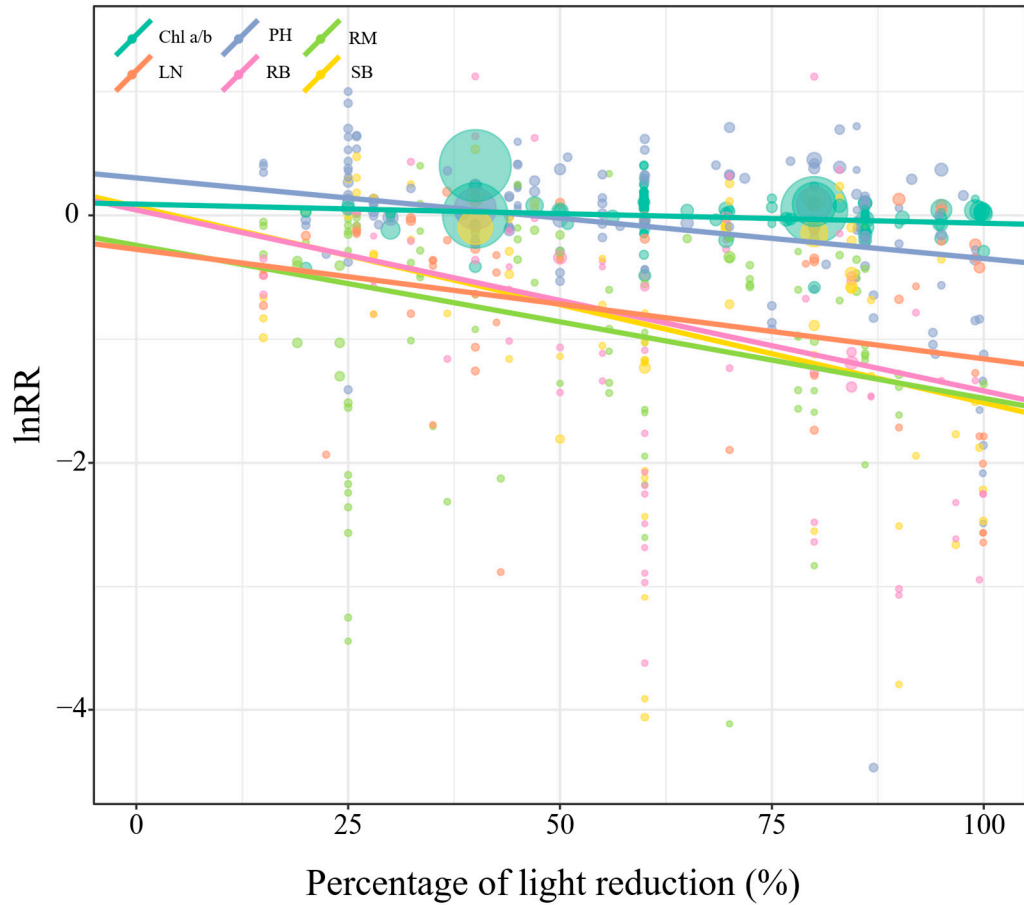


Figure S6 Relationships of $\ln RR$ s of submerged macrophytes traits with the percentage of light reduction in the meta-analysis. RM: ramet number, PH: plant height, SB: shoot biomass, RB: root biomass, LN: leaf number, Chl a/b: chlorophyll a/b ratio.

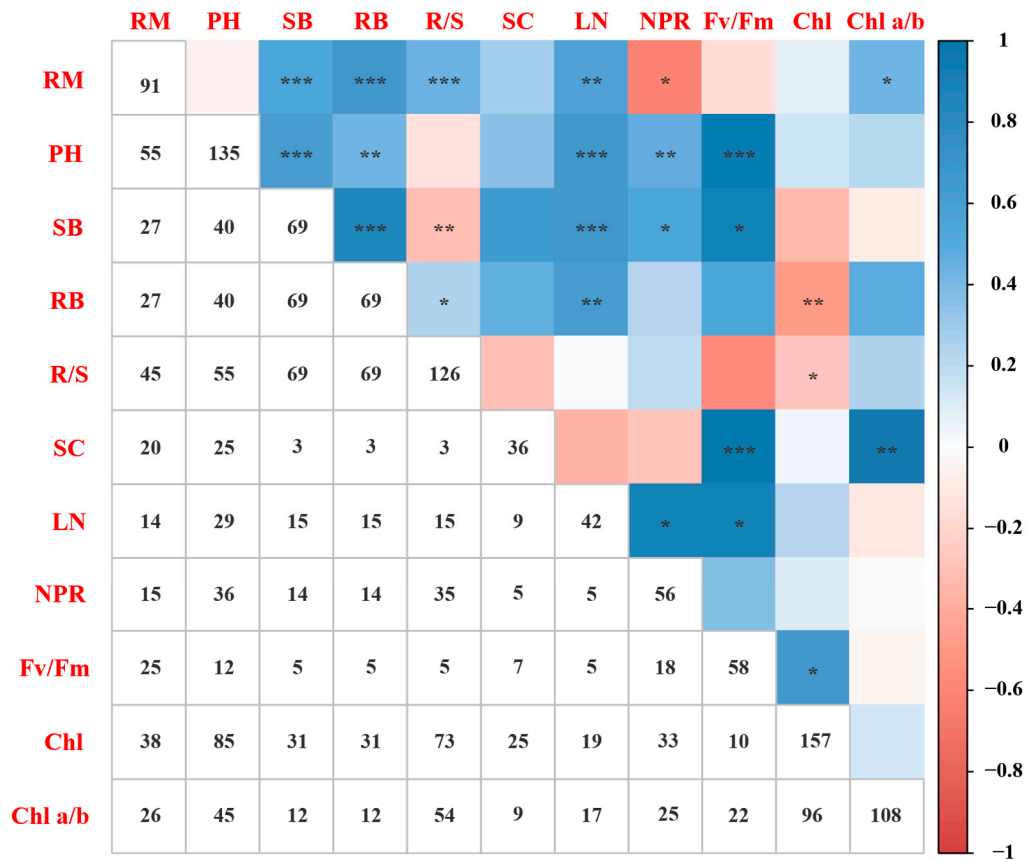


Figure S7 Heatmap of the Pearson's correlation coefficients between lnRRs of the paired whole-plants and leaf traits in the meta-analysis. The top-right of the matrix indicates the strength and direction of the correlation, and the bottom-left of the matrix indicates the number of observations (colors corresponding to the correlations). Significant level: * $P < .05$, ** $P < .01$, *** $P < .001$. RM: ramet number PH: plant height, R/S: root-to-shoot ratio, SB: shoot biomass, RB: root biomass, SC: soluble carbohydrates, LN: leaf number, NPR: net photosynthesis rate, Fv/Fm: leaf maximal quantum yield of photosystem II complex, Chl: chlorophyll content, Chl a/b: chlorophyll a/b ratio.

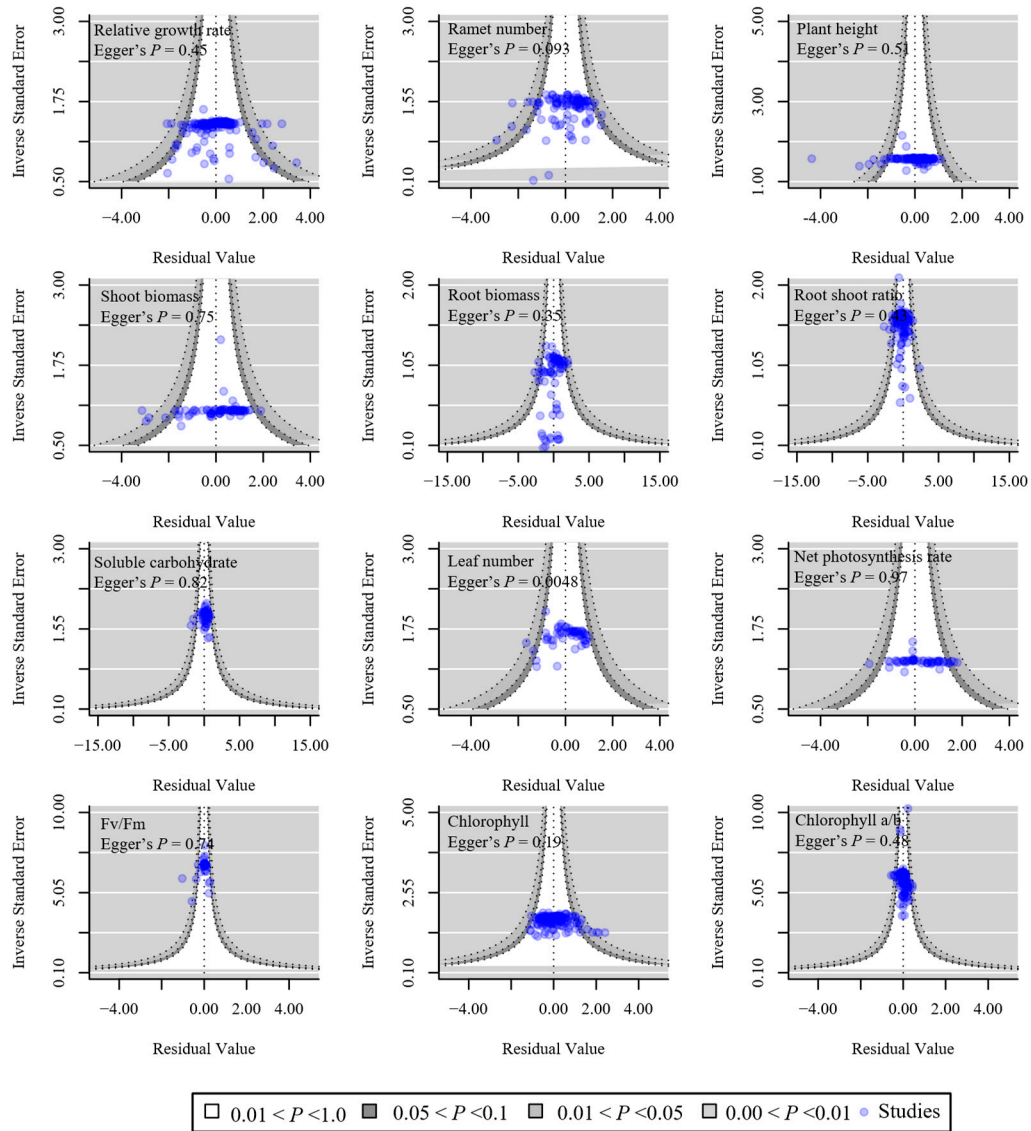


Figure S8 Contour-enhanced funnel plots for null-model residuals and P value of the Egger's test for lnRR of each variable. Shading colors in each plot represent the significance levels of the residual estimates. Funnel plot symmetry is detected by the Egger's test at 0.05 level.

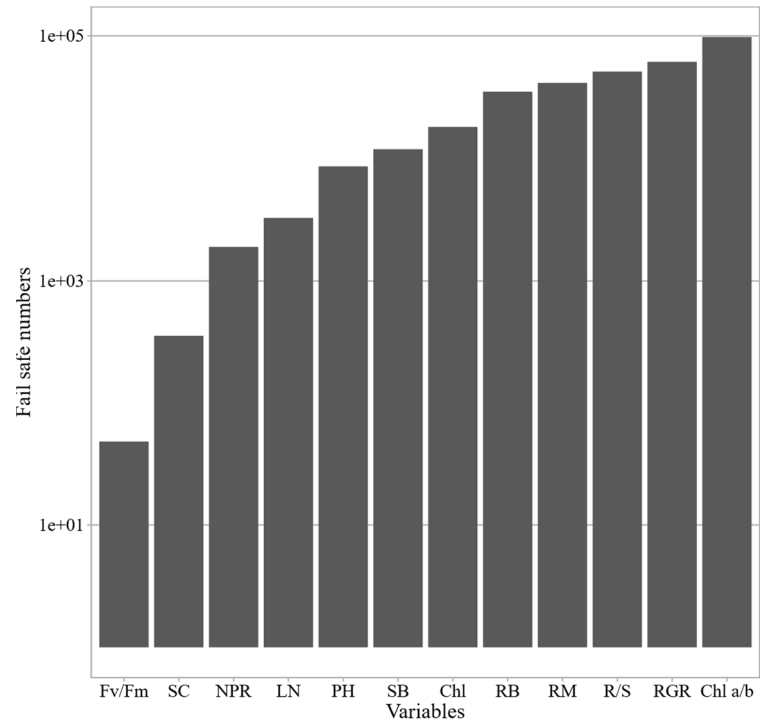


Figure S9 Bar plots of fail-safe numbers of each variable.

Table S1 List of primary studies, species and traits included in the meta-analysis

No.	data source	species	Traits
1	Carter et al., 1996	<i>Vallisneria americana</i>	RGR
2	Kurtz et al., 2003	<i>Vallisneria americana</i>	SB, RB, R/S, LN, Chl,
3	Asaeda et al., 2004	<i>Potamogeton perfoliatus</i>	SB, RB, R/S, PH, RM, NPR, Chl
4	Boedeltje et al., 2005	<i>Potamogeton alpinus</i>	R/S, RM
5	Li et al., 2005	<i>Vallisneria natans</i>	RGR
6	Chen et al., 2006	<i>Potamogeton crispus</i>	Fv/Fm
7	Li, 2006	<i>Vallisneria natans</i>	SC, LN
8	Xiao, 2006	<i>Potamogeton crispus</i>	Fv/Fm, Chl a/b
9	Xiao et al. 2006	<i>Potamogeton wrightii</i> <i>Vallisneria natans</i>	NPR, Fv/Fm, Chl a/b
10	Imamoto et al., 2007	<i>Vallisneria natans</i> <i>Potamogeton maackianus</i> <i>Elodea nuttallii</i>	PH, RGR
11	Xie et al., 2007	<i>Myriophyllum spicatum</i>	SB, RB, R/S
12	Chen et al., 2008	<i>Potamogeton crispus</i>	SB, RB, R/S, PH, LN, RM
13	Zhou et al., 2008	<i>Potamogeton crispus</i>	SB, RB, R/S, PH, LN, NPR, Fv/Fm,
14	Zhou et al., 2008	<i>Elodea nuttallii</i>	PH, LN, Chl, Chl a/b
15	Zhu et al., 2008	<i>Elodea canadensis</i> <i>Myriophyllum spicatum</i> <i>Heteranthera dubia</i>	SB, RB, R/S, RM
16	Angelstein et al., 2009	<i>Elodea nuttallii</i>	RGR, Chl, Chl a/b
17	Cao et al., 2009	<i>Potamogeton crispus</i>	SB, RB, R/S, SC
18*	Zhu, 2009	<i>Hydrilla verticillata</i>	PH, RGR, RM, SC, NPR, Fv/Fm, Chl, Chl a/b
19	Sultana et al., 2010	<i>Potamogeton perfoliatus</i>	SB, RB, R/S
20*	Wang, 2010.	<i>Vallisneria natans</i>	SB, RB, R/S, Chl, RGR
21	Zhang et al., 2010	<i>Potamogeton crispus</i>	SC
22	Cao et al., 2011	<i>Ceratophyllum demersum</i> <i>Myriophyllum spicatum</i> <i>Vallisneria natans</i>	SC, RGR
23	Zhu et al., 2011	<i>Hydrilla verticillata</i>	PH, RM, SC, Chl, Chl a/b
24	Ge et al., 2012	<i>Myriophyllum spicatum</i>	SC, RGR
25	Riis et al., 2012	<i>Egeria densa</i> <i>Elodea canadensis</i> <i>Lagarosiphon major</i>	R/S, PH, RM, NPR, RGR
26	Yuan et al., 2012	<i>Vallisneria spinulosa</i>	SB, RB, R/S, RM
27	Lu et al., 2013	<i>Vallisneria natans</i> <i>Myriophyllum spicatum</i>	RM, Fv/Fm, RGR

28	Malheiro et al., 2013	<i>Myriophyllum aquaticum</i>	SB, RB, R/S, Chl, Chl a/b, RGR
29	Zhao et al., 2013	<i>Vallisneria natans</i>	SB, RB, R/S, PH, LN, RM
30	Cao et al., 2014	<i>Vallisneria natans</i>	LN, RM, Chl, Chl a/b
31	Lang et al., 2014	<i>Potamogeton wrightii</i> <i>Stuckenia pectinata</i>	Fv/Fm
32	Zhao et al., 2014	<i>Ottelia acuminata</i>	PH
33	Eller et al., 2015	<i>Elodea canadensis</i> <i>Egeria densa</i> <i>Hydrilla verticillata</i> <i>Ceratophyllum demersum</i>	R/S, PH, RM, Chl, Chl a/b, RGR
34	Hussner et al., 2015	<i>Hydrilla verticillata</i> <i>Egeria densa</i> <i>Lagarosiphon major</i> <i>Myriophyllum triphyllum</i>	R/S, Chl, Chl a/b, RGR
35	Hussner et al., 2015	<i>Myriophyllum heterophyllum</i> <i>Myriophyllum spicatum</i>	R/S, NPR, Chl, Chl a/b, RGR
36	Song et al., 2015	<i>Myriophyllum spicatum</i>	Chl
37	Lin et al., 2016	<i>Stuckenia pectinata</i> <i>Potamogeton maackianus</i> <i>Potamogeton wrightii</i> <i>Ceratophyllum demersum</i> <i>Vallisneria natans</i> <i>Hydrilla verticillata</i> <i>Myriophyllum spicatum</i>	PH, RM, SC, Chl, RGR
38	Zhang, 2016	<i>Vallisneria natans</i>	PH, LN, RM, Chl, Chl a/b
39	Cao et al., 2018	<i>Potamogeton crispus</i>	PH, LN, Chl, Chl a/b
40	Jiang et al., 2018	<i>Hydrilla verticillata</i> <i>Myriophyllum spicatum</i> <i>Ceratophyllum demersum</i> <i>Cabomba caroliniana</i> <i>Vallisneria natans</i> <i>Potamogeton wrightii</i>	Fv/Fm
41	Li et al., 2018	<i>Hydrilla verticillata</i> <i>Vallisneria natans</i> <i>Najas marina</i>	Chl
42	Xue, 2018	<i>Vallisneria natans</i> <i>Elodea nuttallii</i>	PH, Chl, Chl a/b
43	Kankanamge et al., 2019	<i>Egeria densa</i> <i>Elodea canadensis</i> <i>Ceratophyllum demersum</i> <i>Nitella aff. Cristata</i>	SB, RB, R/S, PH, NPR, Chl, RGR
44	He et al., 2019	<i>Elodea nuttallii</i>	SB, RB, R/S, PH, RM, RGR

45	Hillmann et al., 2019	<i>Myriophyllum spicatum</i> <i>Ruppia maritima</i>	R/S, RGR
46	Hu et al., 2019	<i>Stuckenia pectinata</i>	SB, RB, R/S
47	Li et al., 2019	<i>Vallisneria spirulosa</i>	PH, LN
48	Tan et al., 2019	<i>Myriophyllum spicatum</i> <i>Potamogeton maackianus</i> <i>Vallisneria natans</i>	PH, RM
49	Zhang, 2019	<i>Rotala rotundifolia</i>	SB, RB, R/S, PH, LN, Chl, Chl a/b
50	Chen et al., 2020	<i>Hydrilla verticillata</i> <i>Vallisneria natans</i>	SB, RB, R/S, PH, RM, SC, Chl, RGR
51	Chen et al., 2020	<i>Potamogeton maackianus</i>	PH, LN
52	Kankanamge et al., 2020	<i>Egeria densa</i> <i>Elodea canadensis</i>	SB, RB, R/S, PH, RGR
53	Yuan et al., 2020	<i>Vallisneria spirulosa</i>	RM, RGR
54	Chotikarn et al., 2021	<i>Elodea canadensis</i>	Fv/Fm, Chl, Chl a/b
55	Malea et al., 2021	<i>Stuckenia pectinata</i>	Chl, Chl a/b, RGR
56	Peng et al., 2021	<i>Vallisneria natans</i>	SB, RB, R/S, PH, LN, RM,
57	Yu et al., 2021	<i>Vallisneria natans</i>	LN, RM
58	Chen et al., 2022	<i>Vallisneria natans</i>	SB, RB, R/S, LN, RM, SC,
59	Yuan et al., 2022	<i>Vallisneria natans</i> <i>Myriophyllum spicatum</i>	SB, RB, R/S, PH, LN, RM, Chl, Chl a/b, RGR
60	Yuan et al., 2022	<i>Vallisneria spirulosa</i>	LN, RM

Note: * denoted two different studies were in the same thesis. Considering the random effects in meta-analysis, we considered the two theses as four study literature.

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