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Corresponding author(s): Jie-Xian Jiang, You-Ming Cai, Bo Li

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Reporting Summary

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Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed
☐	☒ The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement
☐	☒ A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☐	☒ The statistical test(s) used AND whether they are one- or two-sided *Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
☐	☒ A description of all covariates tested
☐	☒ A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☒ A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☐	☒ For null hypothesis testing, the test statistic (e.g. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted *Give P values as exact values whenever suitable.*
☒	☐ For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☐	☒ For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☐	☒ Estimates of effect sizes (e.g. Cohen's *d*, Pearson's *r*), indicating how they were calculated

Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	Studies were selected through a search on the Web of Science (last accessed in May 2019) using the boolean search string: [“plant diversity” OR “plant richness” OR “mix crop*” OR “polyculture” OR “trap crop*” OR “ground cover” OR “vegetation” OR “intercrop*” OR “interplant*”] AND [“predat*” OR “herbivor*” OR “parasit*” OR “wasp*” OR “yield” OR “biomass*” OR “biological control” OR “pest control” OR “natural enem*” OR “pest”]. Reference lists of selected studies were also checked for relevant studies. Means, standard errors (or standard deviations) and sample sizes of the selected variables could be extracted from tables, figures, the main text or supporting information. Data extraction from figures was conducted with Get Data Graph Digitizer 2.25.
Data analysis	R version 3.5.0 was used for all statistical analyses. The R package ‘metafor’ was used for performing meta-regression and analysis of publication bias. The path analyses were performed using the R package ‘piecewiseSEM’ in conjunction with the R package ‘nlme’. The significance level 0.05 was used for all tests.

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors/reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Research guidelines for submitting code & software for further information.

Data

Policy information about availability of data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A list of figures that have associated raw data
- A description of any restrictions on data availability

All data needed to evaluate the conclusions in the paper are present in the paper and/or the Supplementary Materials.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☐ Behavioural & social sciences ☒ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	Studies were selected through a search on the Web of Science (last accessed in May 2019) using the boolean search string: ["plant diversity" OR "plant richness" OR "mix crop*" OR "polyculture" OR "trap crop*" OR "ground cover" OR "vegetation" OR "intercrop*" OR "interplant*"] AND ["predat*" OR "herbivor*" OR "parasit*" OR "wasp*" OR "yield" OR "biomass*" OR "biological control" OR "pest control" OR "natural enem*" OR "pest"]. Reference lists of selected studies were also checked for relevant studies. In total, more than 40000 papers were screened for relevance and 351 were finally selected. Means, standard errors (or standard deviations), and sample sizes of the selected variables could be extracted from tables, figures, the main text or supporting information. Data extraction from figures was conducted with Get Data Graph Digitizer 2.25. When we obtained the data, we analyzed the effect size of response to plant species diversity for trophic groups, the effect of plant species diversity on bi-trophic associations and finally analyzed the effect of plant species diversity across tri-trophic levels.
Research sample	2914 observations from 351 studies were finally selected to conduct this global meta-analysis.
Sampling strategy	We collected all available studies matching the inclusion criteria to ensure the largest possible sample size for the analyses. More than 40000 papers were reviewed for relevance and 351 were finally selected based on the following criteria: (1) the study included a treatment that increased the number of plant species, and the use of pesticides was the same for the control (single/lowest plant species) and the treatment (diverse plant species); (2) the measurements of treatment and control groups were conducted at the same spatiotemporal scale; (3) the means, standard errors (or standard deviations), and sample sizes of the selected variables could be extracted from tables, figures, the text or supporting information. When a study included different levels of plant species, measurements for lowest plant species vs. different plant species were considered as independent observations. Data extraction from figures was conducted with Get Data Graph Digitizer 2.25. We first used the data that the authors had presented the average values of multiple sampling date and multiple sampling year in a cited study. If these average values were not given in a certain paper, we used the data of the latest sampling date when a study took measurements at different points in time.
Data collection	First, we (mainly from Nian-Feng Wan, Xiang-Rong Zheng and Li-Wan Fu) selected the papers through a search on the Web of Science (last accessed in May 2019) , and then extracted the data from the papers. Second, we established a datasheet for trophic groups (herbivores, predators, parasitoids and plants). In this datasheet, we included (i) herbivory abundance, diversity and its damage, (ii) predator abundance, diversity and predation rate, (iii) parasitoid abundance, diversity and parasitism rate, and (iv) plant growth, reproduction and quality.
Timing and spatial scale	The start and stop dates of data collection was in November 2017 and May 2019, respectively.
Data exclusions	When we collected the data, the data were excluded in this meta-analysis if they did not reach the following criteria: (1) the study included a treatment that increased the number of plant species, and the use of pesticides was the same for the control (single/lowest plant species) and the treatment (diverse plant species); (2) the measurements of treatment and control groups were conducted at the same spatiotemporal scale; (3) the means, standard errors (or standard deviations), and sample sizes of the selected variables could be extracted from tables, figures, the text or supporting information.
Reproducibility	The readers can extract the data from the 351 papers which were selected in this paper to reproduce the results.
Randomization	We used a mixed-effects meta-regression to account for between-study, within-study and sampling variances.
Blinding	Our study were based on existing data, therefore blinding is not relevant to our study.

Did the study involve field work? ☐ Yes ☒ No

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology
☒	☐ Animals and other organisms
☒	☐ Human research participants
☒	☐ Clinical data

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging