

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
<i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i> |
| ☐ | ☒ 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
<i>Give P values as exact values whenever suitable.</i> |
| ☒ | ☐ 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 No computer code was used for data collection.

Data analysis Data were analysed using code developed by authors (R language, version 9.4 and 4.2.3) and common statistical methods : random forest (randomForest R package, version 4.7-1.1), linear models (olsrr R package, version 0.5.3), mixed models (lme4 R package, version 1.1-32), Kruskal & Wallis test (R core). All analyses are fully described in the Methods section. The main R procedures that were used have been deposited in the <https://entrepot.recherche.data.gouv.fr> database under accession link <https://doi.org/10.57745/3OIGHB>. Complementary information can be provided by authors on request.

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 and 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

The datasets generated in this study (EAN, TDN, SBD, TED) have been deposited in the <https://entrepot.recherche.data.gouv.fr> database under accession link <https://doi.org/10.57745/3OIGHB> (Etablab Open License 2.0, compatible CC-BY 2.0). Figures 1 to 4, and Table 1, have associated raw data that are available online along with the article files. There is no restriction on data availability.

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](https://www.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	We evaluated to what extent the tree properties (known as functional traits) can explain tree growth, in interactions with local environment (soil properties, climate).
Research sample	To be able to study the influence of functional traits on tree growth, independently from variations of environmental conditions, we studied tree growth in common gardens. In such experimental sites, different tree species were growing in the same conditions, enabling us to explore any growth-trait relationship. To study the possible interactions with local environment, we included in our study as many common gardens as possible (n=160). Trait data were compiled, using published works and our own samplings.
Sampling strategy	Data about tree growth were collected mainly by mobilising existing experimental networks: REINFFORCE (re-named EAN in this study) and TreeDivNet. We complemented these datasets with data from the literature and from individual common gardens (by contacting their PI). Data about traits were in majority already existing (see above). We complemented them by sampling 23 tree species in common gardens of the REINFFORCE network (see Methods).
Data collection	The growth data was provided by all networks (or PIs in case of individual common gardens). The checking, structuration, homogenisation and curation of all data were done by Laurent Augusto, Remi Borelle, Marie Charru, and Lucie Bon. Trait data were at first mobilised from a published work (Augusto & Boca, 2022). This dataset was complemented by specific bibliographic requests (WoS, Google Scholar), looking for trait values that were identified as missing. Finally, leaf, root, and wood samples were collected from on-going common gardens, brought to laboratory and measured/analysed.
Timing and spatial scale	Data collection for tree growth and functional traits was carried out from January 2020 (beginning of the study) to June 2023 (date at which the last growth subsets of data were made available). Data analyses began as soon as 2021, and were regularly updated based on the arrival of new data. Data collection for plant traits was initiated in January 2020 and was closed in October 2021 (when the last chemical analyses were finished). Most trees were measured at age between 3 years-old and 90 years-old. The studied sites are distributed throughout the world, with a higher concentration in Western Europe.
Data exclusions	There was no data exclusion for functional traits. For tree growth, we excluded experimental plots that had not enough alive trees to avoid biasing the results.
Reproducibility	The results can be reproduced as the core dataset of the study is available online (see Data availability in the manuscript). The numerous code scripts (in R) are available from the corresponding authors upon request.
Randomization	Most of the TreeDivNet common gardens had randomised blocks. In the EAN common gardens, four tree species were in replicated plots, enabling the quantification of internal variability. Some of the SBD common gardens also had replicated blocks.
Blinding	All data (tree growth, traits, site descriptors) were collected by many different operators, working independently. In addition, data were acquired in on-going common gardens led by different PIs. As such, it is very unlikely that all operators could influence each other while collecting data.
Did the study involve field work?	☒ Yes ☐ No

Field work, collection and transport

Field conditions	Root and wood samples were collected at the end of the winter season in a EAN common garden (SW France; cold, rainy conditions). Leaf samples and measurements of photosynthetic capacity were carried out in early summer during a sunny and warm period (but not dry period; see Methods).
Location	Two common gardens were used for samplings, both being in SW France (approx. 45°N, 1°W). They are characterised by temperate conditions (MAT=12-8-12.9°C; MAP=904-930 mm/yr) and coarse-textured acidic soil conditions (podzol and cambisol).
Access & import/export	Both sites are experimental sites, outside any protected area. Access was done by car, following existing roads and paths. No waste was left in situ
Disturbance	Vegetation and soil were left as much as possible untouched. We collected the strictly necessary amount of matter to enable representativeness (see Methods).

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 and archaeology
☒	☐ Animals and other organisms
☒	☐ Human research participants
☒	☐ Clinical data
☒	☐ Dual use research of concern

Methods

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