

## **Supplementary Material**

### **Variation in leaf functional and plant defense traits of introduced *Eucalyptus* species across environmental gradients in the new range in southern China**

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**Supplementary Table S1.** Key morphological characteristics of the three study species, *Eucalyptus saligna*, *E. grandis* and *E. robusta*.

| Species | <i>E. saligna</i>  | <i>E. grandis</i>   | <i>E. robusta</i>   |
|---------|--|---|---|
| Height  | 55m  | 55 (-75) m  | 30m   |
| Bark    | Rough and flaky, base gray, smooth above, bluish gray to cream   | rough, flaky, greyish on basal 1–4 m of trunk, smooth above, powdery, pale grey or white.                                     | Bark rough to small branches, thick, fibrous, spongy, reddish-brown to grey-brown.  |
| Leaf    | petiole 1.5–3 cm long; blade lanceolate to falcate, 9–19 cm long, 1.5–4 cm wide, base oblique or tapering to petiole, discolorous, glossy, green | petiole 1–2.5 cm long; blade lanceolate, 8–18 cm long, 1.5–4 cm wide, discolorous, glossy, darker green above and paler below | petiole 1.5–3 cm long; blade broadly lanceolate to ovate, 8.5–17 cm long, 2.5–7 cm wide. discolorous, glossy, green   |
| Fruit   | cylindrical to obconical or cup-shaped, 0.4–0.9 cm long, 0.4–0.7 cm wide, valves 3 or 4, exserted and erect.                                     | obconical, 0.4–1 cm long, 0.5–0.8 cm wide, valves 4 or 5, exserted or at rim level, incurved                                  | cylindrical, 1–1.6 cm long, 0.7–1.1 cm wide. valves 3 or 4. remaining joined at tips when fruit has dehisced, enclosed or near rim level, rarely slightly exserted. |
| Seed    | brown, 1–2 mm long, cuboid or ovoid  | brown or yellow, 1–1.7 mm long, ovoid or depressed-ovoid  | light brown to yellow, 1.2–1.8 mm long, pyramidal or obliquely pyramidal  |

**Supplementary Table S2.** Mixed-effects model showing the effects of species, latitude, altitude and the interaction between altitude and latitude on the leaf functional traits and chemical defense traits of the three species, *Eucalyptus grandis*, *E. saligna* and *E. robusta*. Species is a random factor in this analysis. Significant *P* values are highlighted in bold.

|                    | Fixed | Latitude |                  | Altitude |                  | Altitude×Latitude |                  | Random | Species   |
|--------------------|-------|----------|------------------|----------|------------------|-------------------|------------------|--------|-----------|
|                    |       | t        | <i>p</i>         | t        | <i>p</i>         | t                 | <i>p</i>         |        | Variables |
| Leaf length        |       | -3.061   | <b>0.002</b>     | -2.675   | <b>0.008</b>     | -0.805            | 0.421            |        | 0.335     |
| Leaf width         |       | 2.526    | <b>0.012</b>     | -2.864   | <b>0.004</b>     | -0.505            | 0.614            |        | 0.568     |
| Leaf area          |       | 0.260    | 0.794            | -3.543   | <b>&lt;0.001</b> | -0.994            | 0.321            |        | 0.487     |
| SLA                |       | -0.107   | 0.915            | -0.009   | 0.993            | -0.073            | 0.942            |        | 0.489     |
| Leaf thickness     |       | 7.528    | <b>&lt;0.001</b> | -2.229   | <b>0.026</b>     | 1.002             | 0.316            |        | 0.777     |
| Leaf petiole       |       | -1.596   | 0.111            | -2.475   | <b>0.014</b>     | -0.677            | 0.499            |        | 0.284     |
| Total N            |       | 0.037    | 0.970            | -3.488   | <b>&lt;0.001</b> | 0.643             | 0.521            |        | 0.316     |
| Phenolic compounds |       | -1.654   | 0.100            | 1.863    | 0.064            | -1.389            | 0.166            |        | 0.165     |
| Total P            |       | 0.795    | 0.428            | -5.590   | <b>&lt;0.001</b> | 3.479             | <b>&lt;0.001</b> |        | 0.551     |

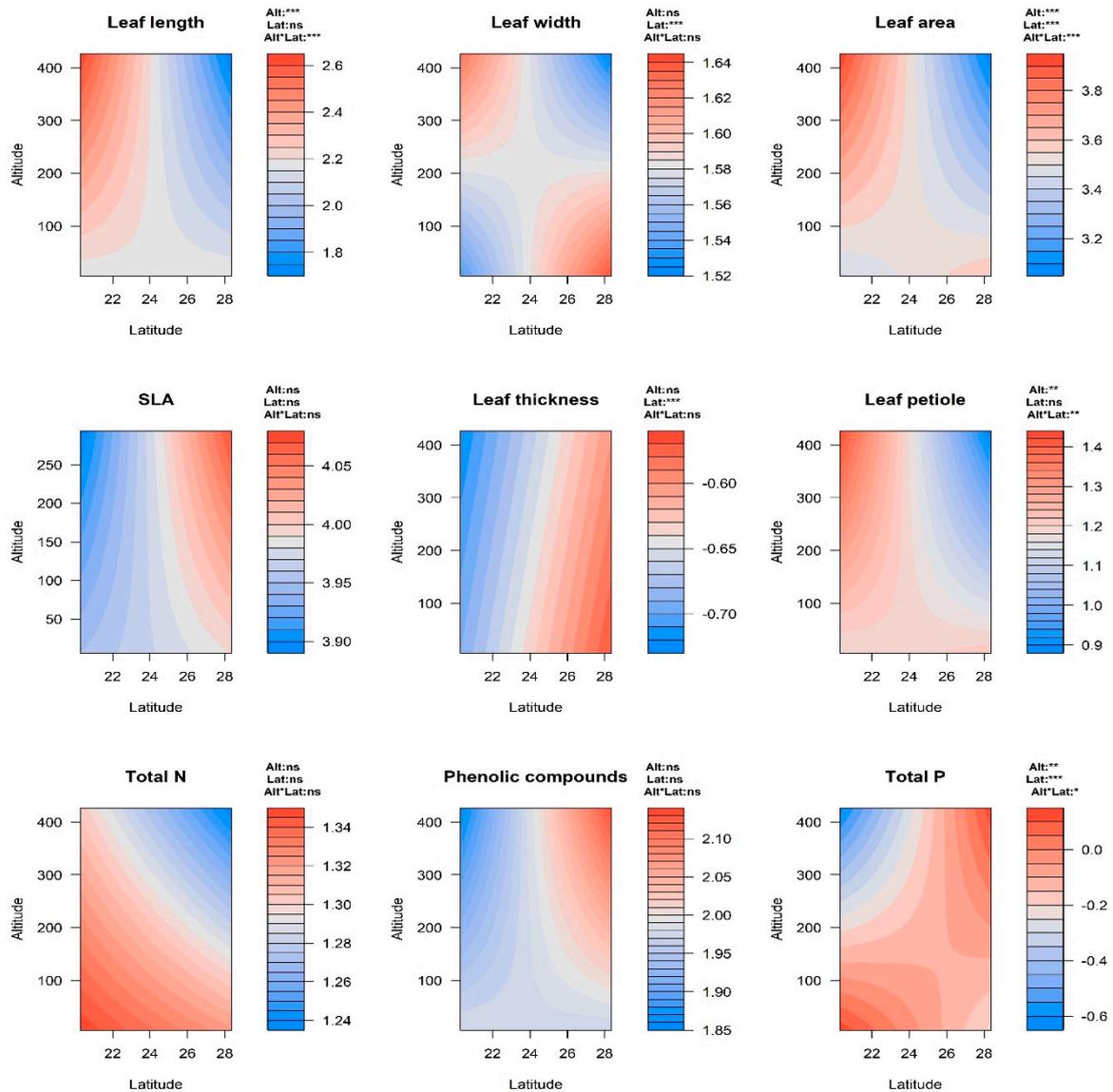
Total N = total nitrogen, Total P = total phosphorus, t = test statistic, *P* = significance

**Supplementary Table S3.** Mixed-effects model showing the effects of species, mean annual temperature (MAT), mean annual precipitation (MAP), and the interaction between MAT and MAP on the leaf functional traits and chemical defense traits of the three species, *Eucalyptus grandis*, *E. saligna* and *E. robusta*. Species is a random factor in this analysis. Significant *P* values are highlighted in bold.

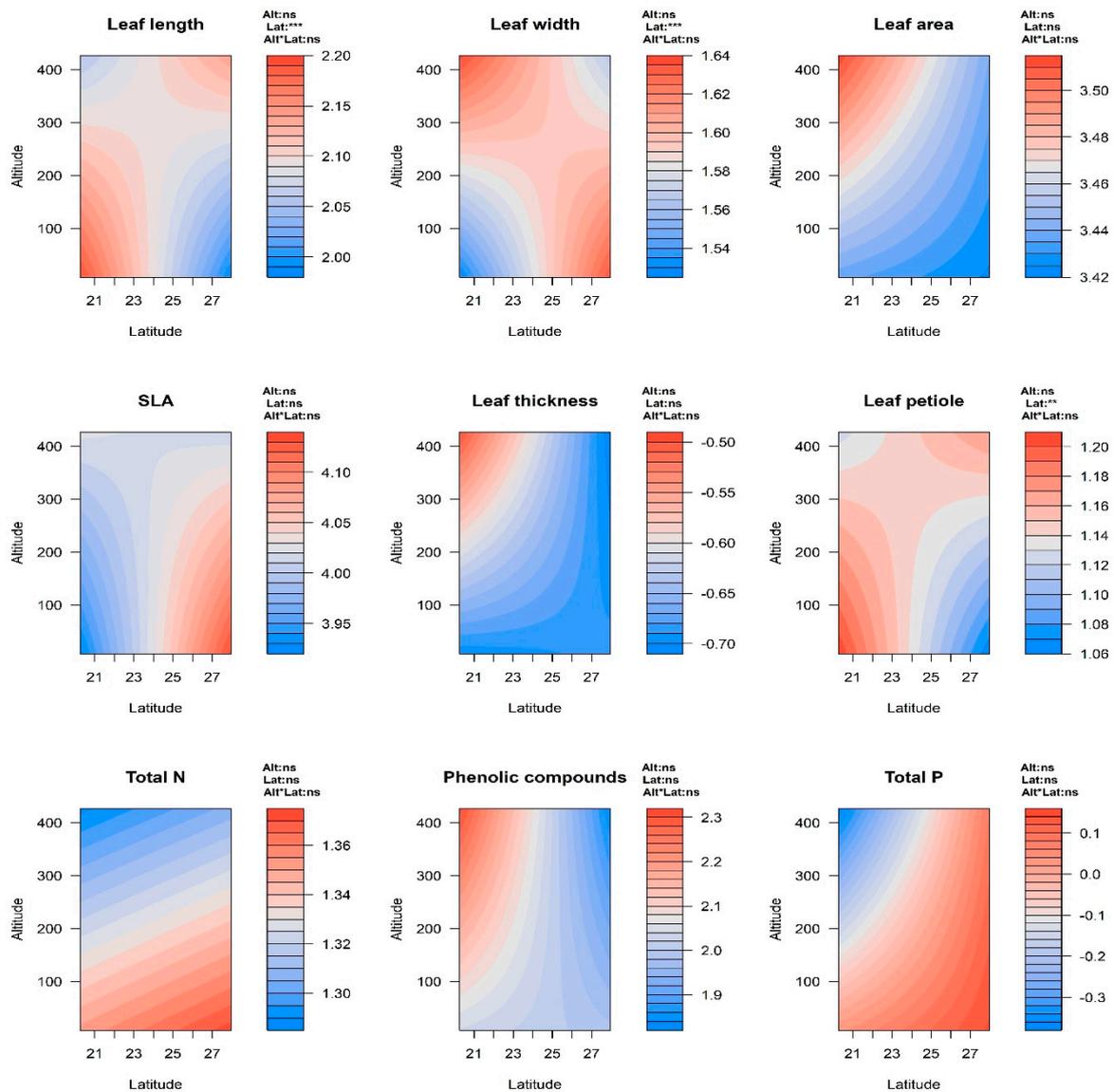
|                    | Fixed | MAT    |                  | MAP    |                  | MAT×MAP |                  | Random | Species   |
|--------------------|-------|--------|------------------|--------|------------------|---------|------------------|--------|-----------|
|                    |       | t      | <i>p</i>         | t      | <i>p</i>         | t       | <i>p</i>         |        | Variables |
| Leaf length        |       | 5.534  | <b>&lt;0.001</b> | -3.228 | <b>0.001</b>     | 0.192   | 0.848            |        | 0.419     |
| Leaf width         |       | -3.527 | <b>&lt;0.001</b> | 0.390  | 0.696            | -0.382  | 0.703            |        | 0.603     |
| Leaf area          |       | 0.391  | 0.696            | -2.023 | <b>0.043</b>     | -0.013  | 0.990            |        | 0.579     |
| SLA                |       | -0.520 | 0.604            | 1.783  | 0.076            | -0.495  | 0.621            |        | 0.539     |
| Leaf thickness     |       | -8.523 | <b>&lt;0.001</b> | -3.573 | <b>&lt;0.001</b> | -0.141  | 0.888            |        | 0.852     |
| Leaf petiole       |       | 4.461  | <b>&lt;0.001</b> | -7.407 | <b>&lt;0.001</b> | 5.813   | <b>&lt;0.001</b> |        | 0.440     |
| Total N            |       | 1.377  | 0.170            | -1.627 | 0.105            | 1.351   | 0.178            |        | 0.171     |
| Phenolic compounds |       | -0.660 | 0.510            | 3.287  | <b>0.001</b>     | -2.475  | <b>0.014</b>     |        | 0.146     |
| Total P            |       | 3.814  | <b>&lt;0.001</b> | -3.428 | <b>&lt;0.001</b> | 3.440   | <b>&lt;0.001</b> |        | 0.465     |

Total N = total nitrogen, Total P = total phosphorus, t = test statistic, *P* = significance

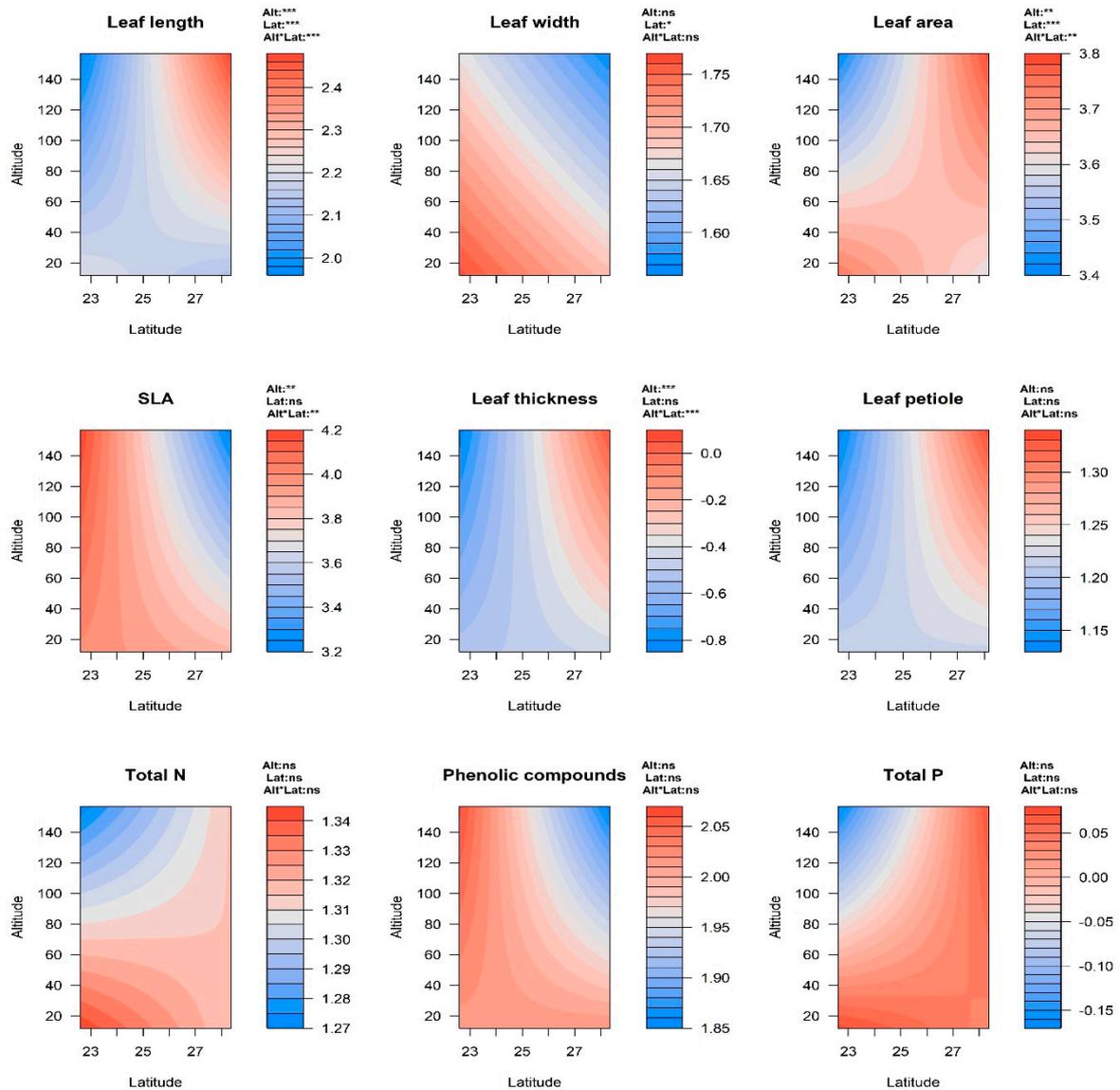
**Supplementary Figure S1.** Contour plots illustrating the effects of altitude (Alt) and latitude (Lat) and their interactions on all leaf functional and chemical defense traits in *Eucalyptus grandis*. Significance of the main effects (Alt and Lat) and the interactions (Alt\*Lat) is indicated as ns (i.e., non-significant,  $P \geq 0.05$ ), \* ( $P < 0.05$ ), \*\* ( $P < 0.01$ ), \*\*\* ( $P < 0.001$ ) in the upper right corner of each plot. Abbreviations: SLA (specific leaf area), total P (total phosphorus) and total N (total nitrogen).



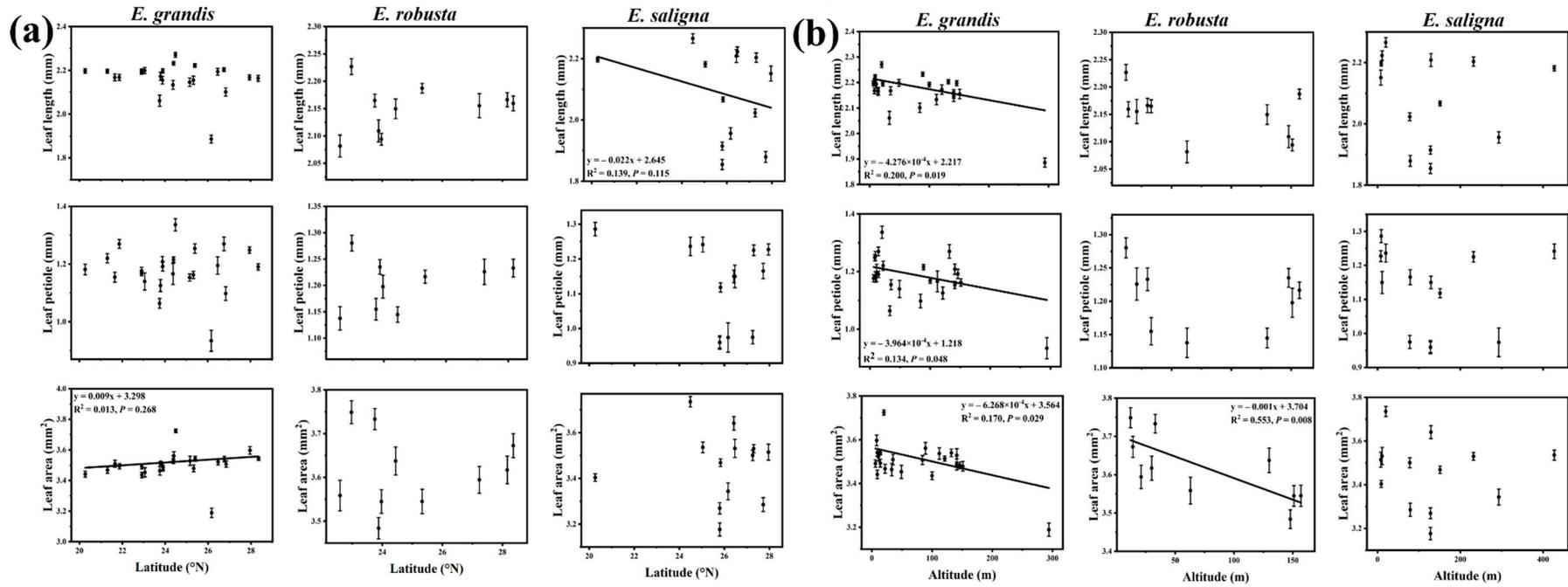
**Supplementary Figure S2.** Contour plots illustrating the effects of altitude (Alt) and latitude (Lat) and their interactions on all leaf functional and chemical defense traits in *Eucalyptus saligna*. Significance of the main effects (Alt and Lat) and the interactions (Alt\*Lat) is indicated as ns (i.e., non-significant,  $P \geq 0.05$ ), \* ( $P < 0.05$ ), \*\* ( $P < 0.01$ ), \*\*\* ( $P < 0.001$ ) in the upper right corner of each plot. Abbreviations: SLA (specific leaf area), total P (total phosphorus) and total N (total nitrogen).



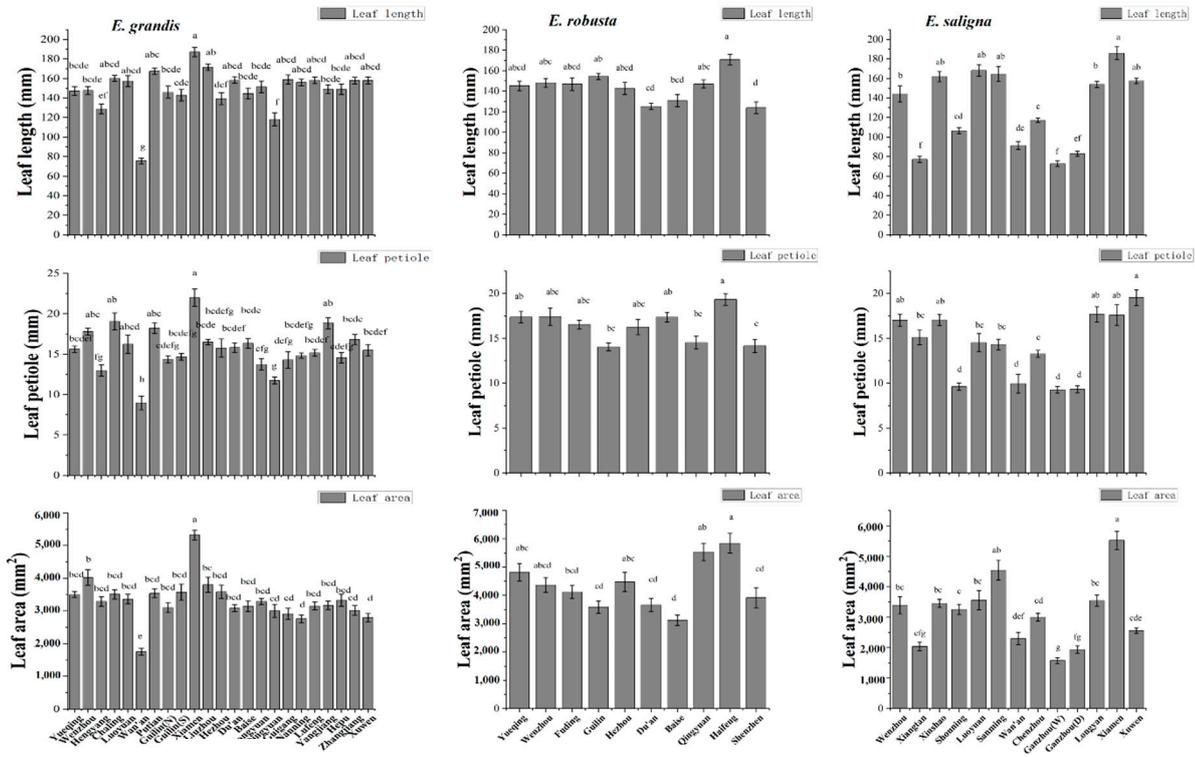
**Supplementary Figure S3.** Contour plots illustrating the effects of altitude (Alt) and latitude (Lat) and their interactions on all leaf functional and chemical defense traits in *Eucalyptus robusta*. Significance of the main effects (Alt and Lat) and the interactions (Alt\*Lat) is indicated as ns (i.e., non-significant,  $P \geq 0.05$ ), \* ( $P < 0.05$ ), \*\* ( $P < 0.01$ ), \*\*\* ( $P < 0.001$ ) in the upper right corner of each plot. Abbreviations: SLA (specific leaf area), total P (total phosphorus) and total N (total nitrogen).



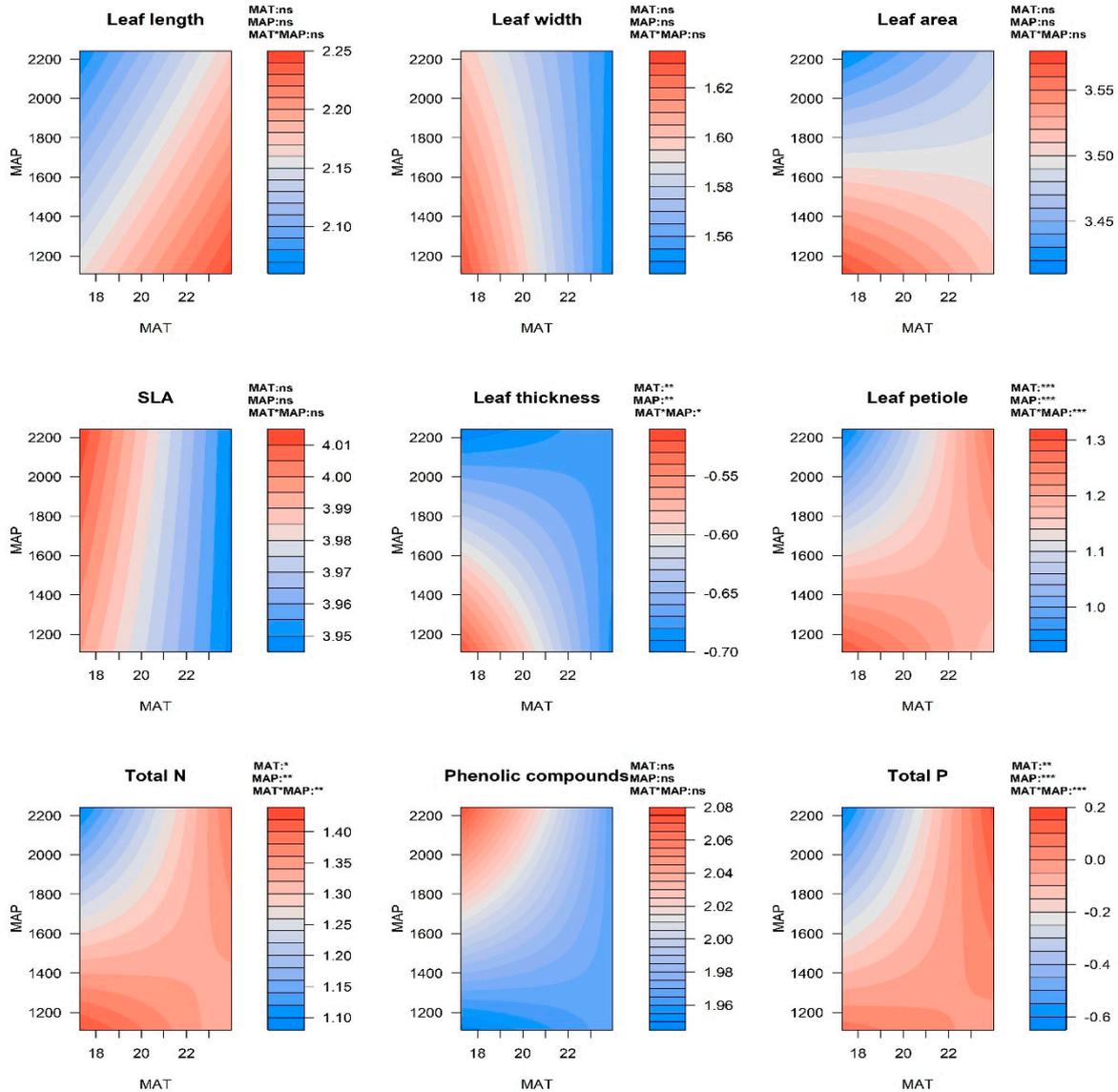
**Supplementary Figure S4.** Relationship between the leaf functional traits (leaf length, leaf petiole length and leaf area) of each introduced *Eucalyptus* species and (a) latitude and (b) altitude in southern China.



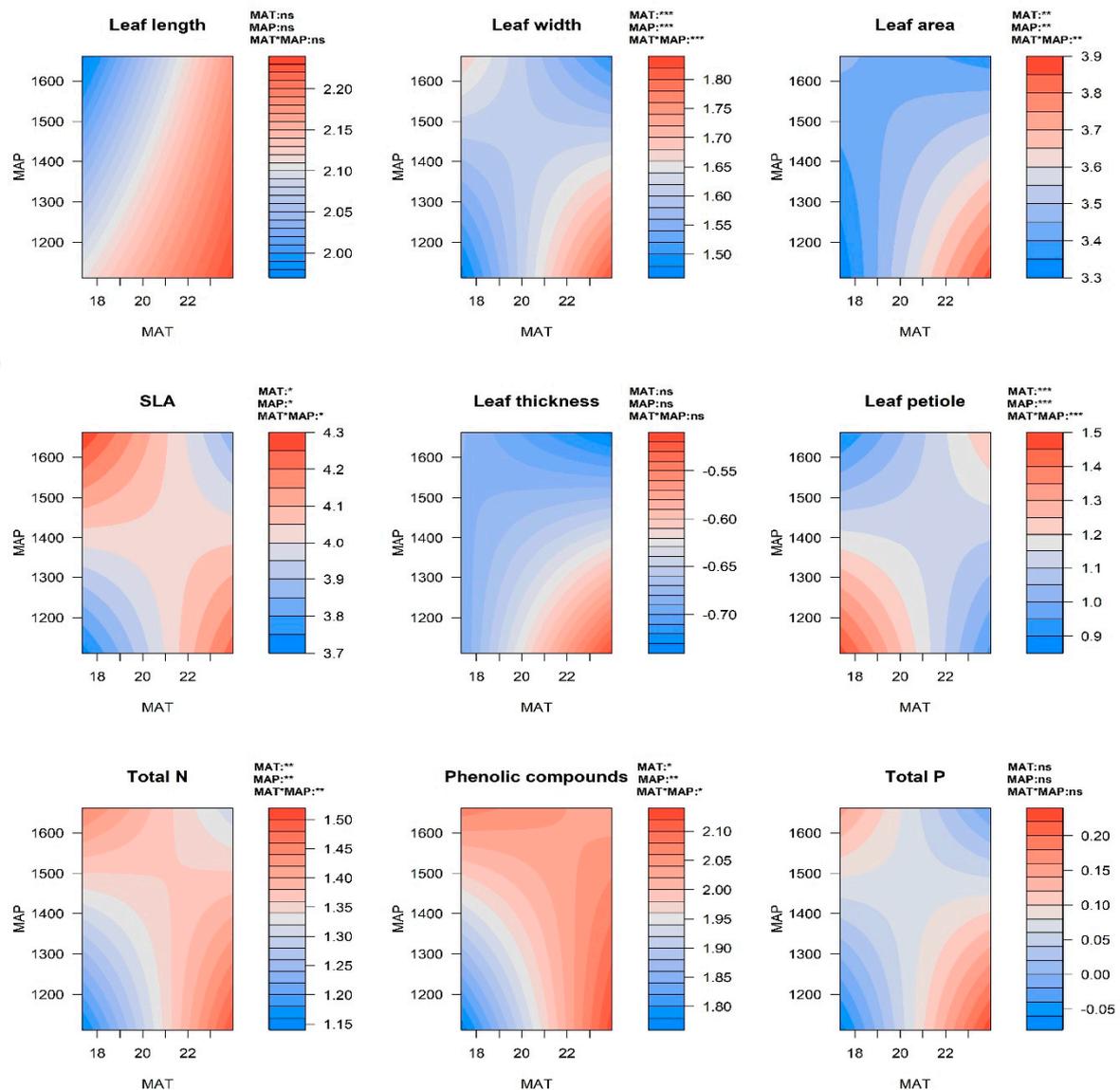
**Supplementary Figure S5.** Differences in leaf functional traits across locations of introduced *Eucalyptus grandis*, *E. robusta* and *E. saligna* in southern China. Significant differences ( $P < 0.05$ , Tukey's HSD post-hoc comparison) among sites are denoted by different letters above the bars.



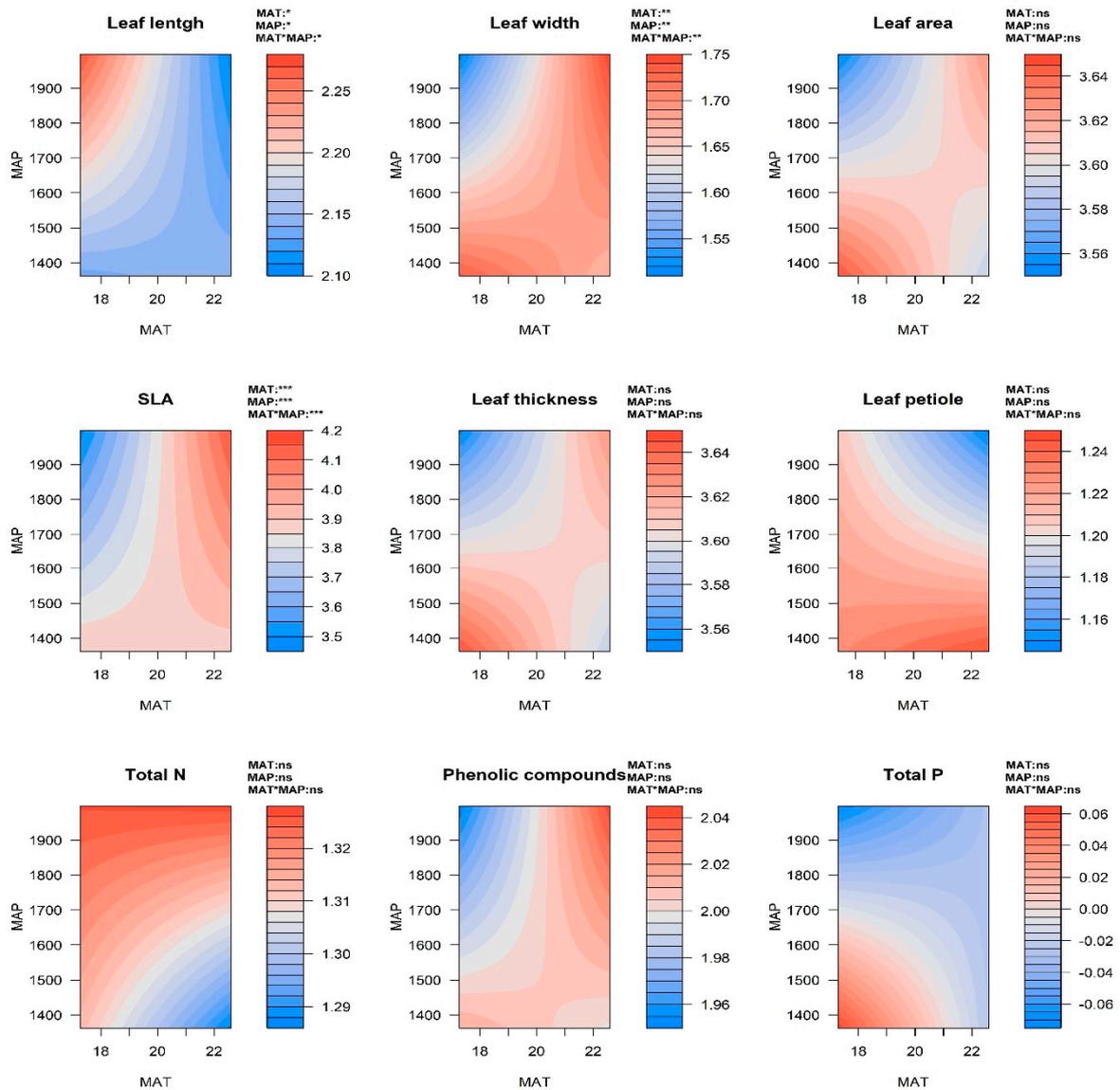
**Supplementary Figure S6.** Contour plots illustrating the effects of mean annual precipitation (MAP) and mean annual temperature (MAT) and their interactions on all leaf functional and chemical defense traits in *Eucalyptus grandis*. Significance of the main effects (MAP and MAT) and the interactions (MAP\*MAP) is indicated as ns (i.e., non-significant,  $P \geq 0.05$ ), \* ( $P < 0.05$ ), \*\* ( $P < 0.01$ ), \*\*\* ( $P < 0.001$ ) in the upper right corner of each plot. Abbreviations: SLA (specific leaf area), total P (total phosphorus) and total N (total nitrogen).



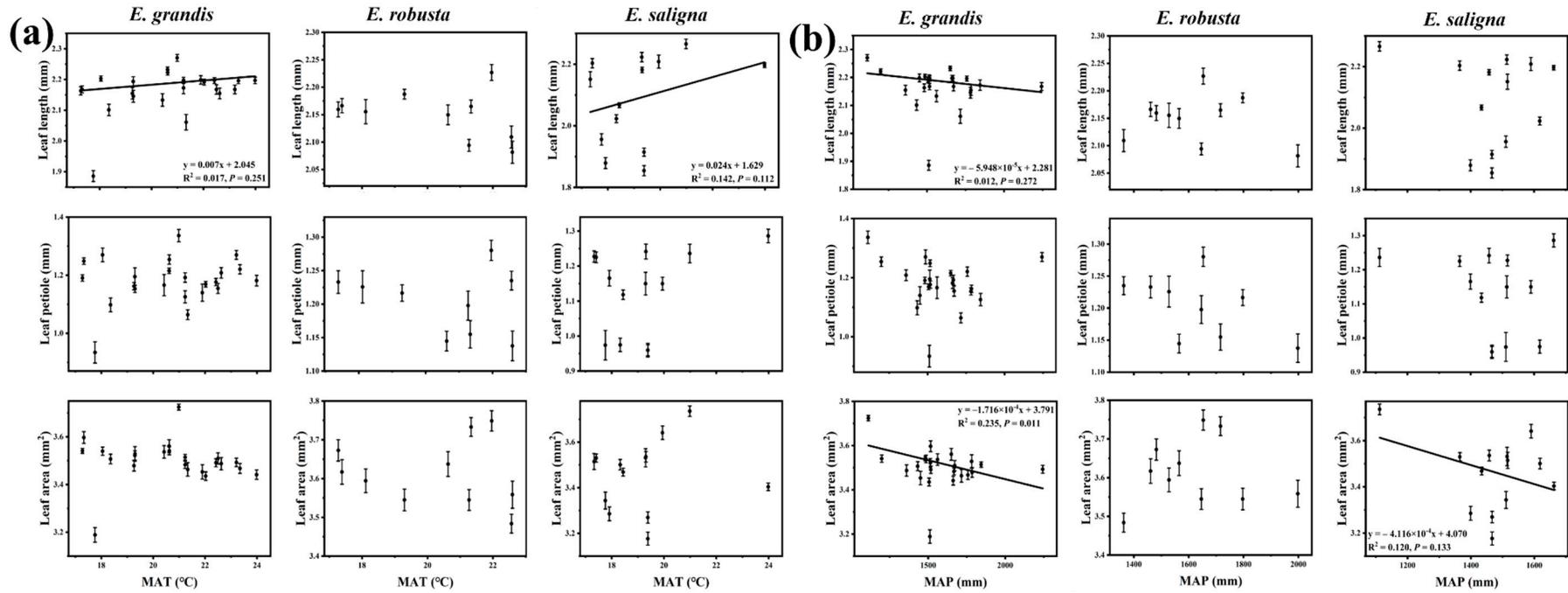
**Supplementary Figure S7.** Contour plots illustrating the effects of mean annual precipitation (MAP) and mean annual temperature (MAT) and their interactions on all leaf functional and chemical defense traits in *Eucalyptus saligna*. Significance of the main effects (MAP and MAT) and the interactions (MAP\*MAP) is indicated as ns (i.e., non-significant,  $P \geq 0.05$ ), \* ( $P < 0.05$ ), \*\* ( $P < 0.01$ ), \*\*\* ( $P < 0.001$ ) in the upper right corner of each plot. Abbreviations: SLA (specific leaf area) and total P (total phosphorus) and total N (total nitrogen).



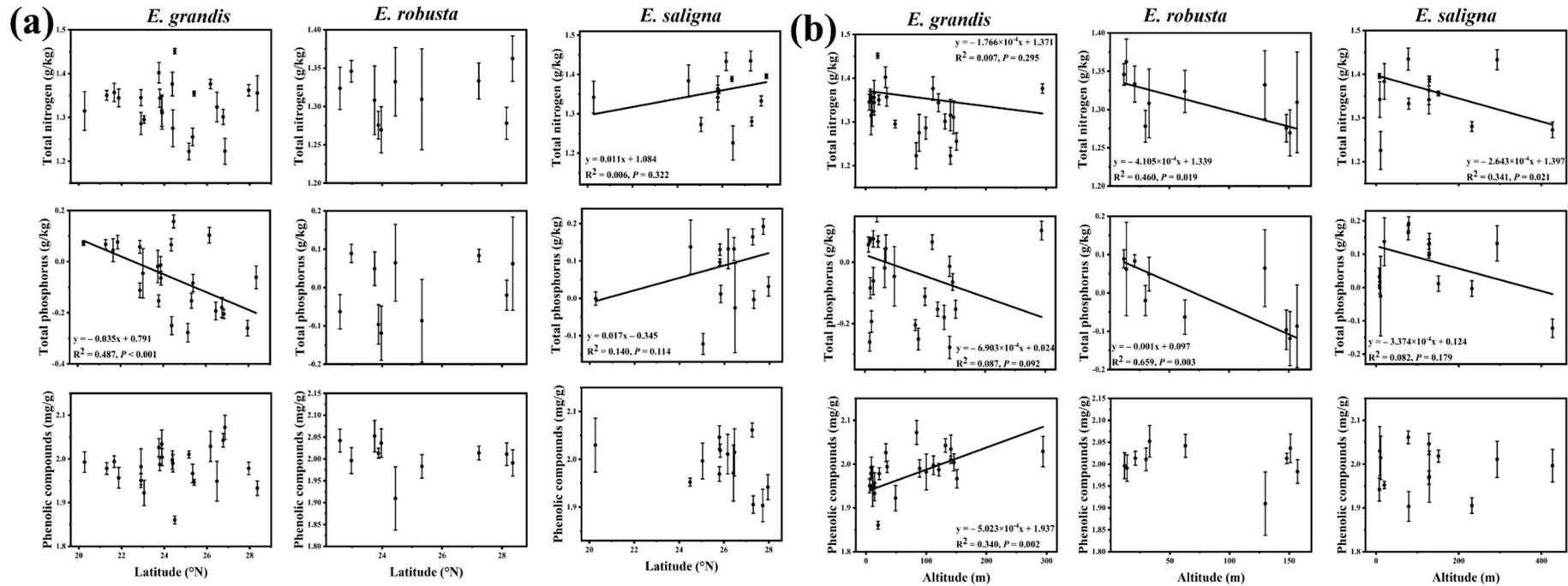
**Supplementary Figure S8.** Contour plots illustrating the effects of mean annual precipitation (MAP) and mean annual temperature (MAT) and their interactions on all leaf functional and chemical defense traits in *Eucalyptus robusta*. Significance of the main effects (MAP and MAT) and the interactions (MAP\*MAT) is indicated as ns (i.e., non-significant,  $P \geq 0.05$ ), \* ( $P < 0.05$ ), \*\* ( $P < 0.01$ ), \*\*\* ( $P < 0.001$ ) in the upper right corner of each plot. Abbreviations: SLA (specific leaf area), total P (total phosphorus) and total N (total nitrogen).



**Supplementary Figure S9.** Relationship between leaf functional traits (leaf length, leaf petiole length and leaf area) of each introduced *Eucalyptus* species and (a) mean annual temperature (MAT) and (b) mean annual precipitation (MAP) in southern China.



**Supplementary Figure S10.** Relationship between chemical defense traits (leaf nitrogen, leaf phosphorus and phenolic compounds) of each introduced *Eucalyptus* species and (a) latitude and (b) altitude in southern China.



**Supplementary Figure S11.** Relationship between chemical defense traits (leaf nitrogen, leaf phosphorus and phenolic compounds) of each introduced *Eucalyptus* species and (a) mean annual temperature (MAT) and (b) mean annual precipitation (MAP) in southern China.

