Supplementary materials

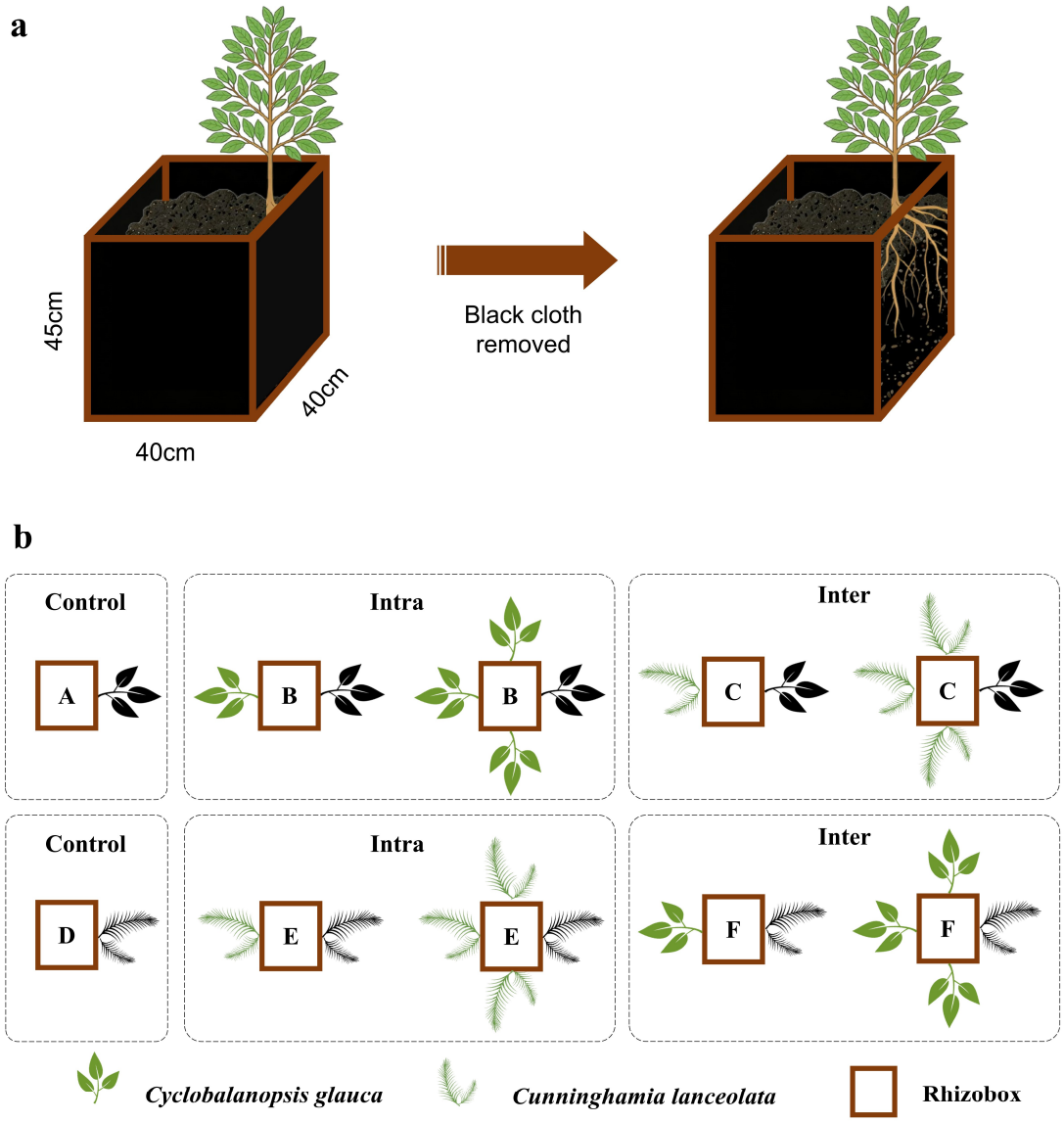

Figure S1. Schematic diagram of the custom rhizobox and the competition treatments. a, The rhizobox consisted of opaque panels on all sides except for the transparent observation panel. Each rhizobox measured 40 × 40 × 45 cm (length × width × depth). A removable black cloth covered the transparent observation panel to exclude light and was removed only during root imaging. b, Each rhizobox contained one target seedling (shown in deep color) positioned adjacent to the transparent observation panel and either no neighboring seedling (Control) or one or three neighboring seedlings of the same species (Intra) or the other species (Inter).

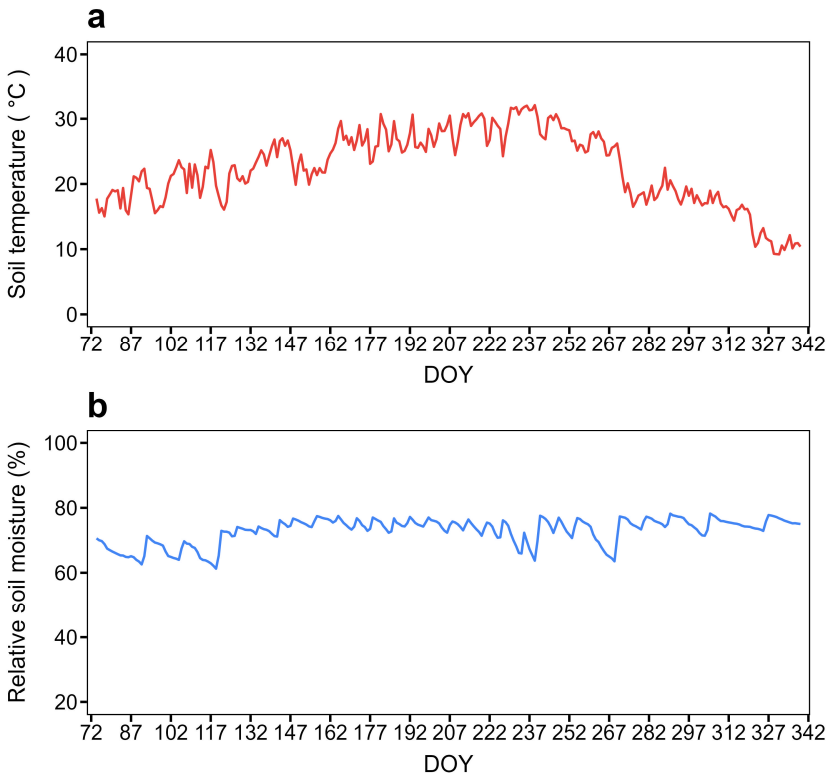

Figure S2. Soil temperature and relative soil moisture in the custom rhizobox during the experimental period. Relative soil moisture expressed as the percentage of field capacity (% FC). Values of 100% indicate the field capacity of the mixed growth substrate rather than complete soil saturation.

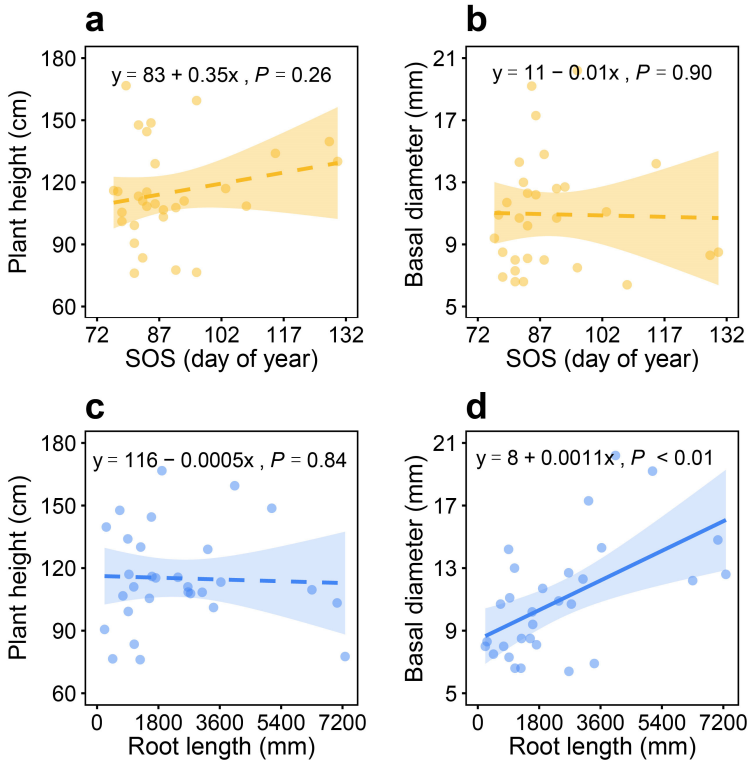

Figure S3. Relationships between spring belowground and aboveground traits. Relationships between the start of the root growing season (SOS) and final plant height (a) and final basal diameter (b), and between mean spring root length and final plant height (**c**) and final basal diameter (**d**). Data from *Cyclobalanopsis glauca* and *Cunninghamia lanceolata* were pooled. Solid and dashed lines indicate significant and non-significant linear relationships, respectively. Shaded areas represent 95% confidence intervals. Each panel includes 30 target seedlings (3 control, 6 intraspecific competition, and 6 interspecific competition seedlings per species).

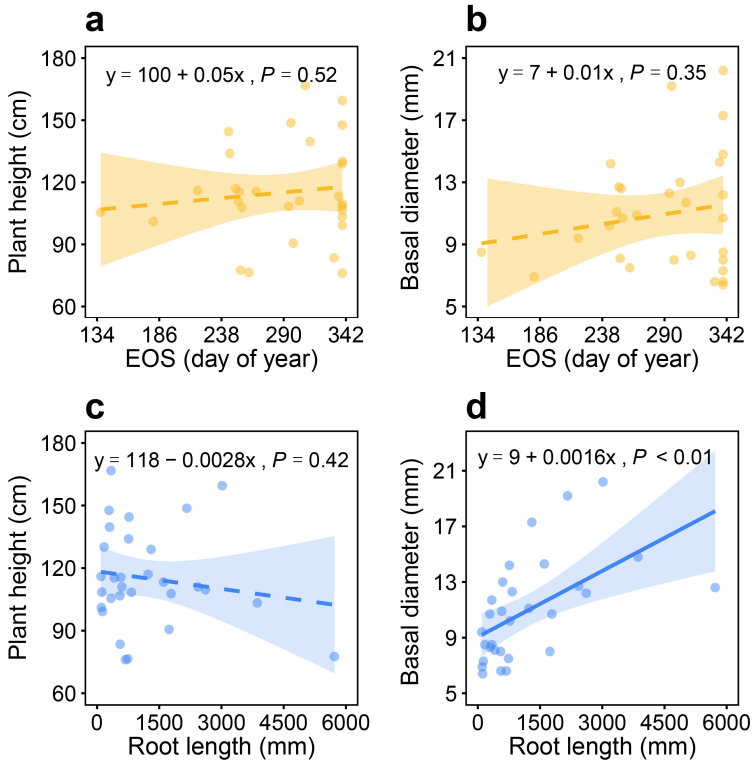

Figure S4. Relationships between autumn belowground and aboveground traits. Relationships between the end of the root growing season (EOS) and final plant height (a) and final basal diameter (b), and between mean autumn root length and final plant height (c) and final basal diameter (d). Data from *Cyclobalanopsis glauca* and *Cunninghamia lanceolata* were pooled. Solid and dashed lines indicate significant and non-significant linear relationships, respectively. Shaded areas represent 95% confidence intervals. Each panel includes 30 target seedlings (3 control, 6 intraspecific competition, and 6 interspecific competition seedlings per species).

Table S1. Initial plant height and basal diameter of *Cyclobalanopsis glauca* and *Cunninghamia lanceolata* under different competition treatments. Values are presented as means ± standard errors (SE). Different letters indicate significant differences among competition treatments within each species (Tukey's HSD, $p < 0.05$).

Species	Treatment	Plant height (cm)	Basal diameter (mm)
Cyclobalanopsis glauca	Control	60.27 ± 6.50[a]	3.83 ± 0.47[a]
	Intraspecific	72.80 ± 9.99[a]	4.55 ± 0.48[a]
	Interspecific	83.55 ± 3.76[a]	4.27 ± 0.10[a]
Cunninghamia lanceolata	Control	100.27 ± 6.43[a]	11.98 ± 0.94[a]
	Intraspecific	89.92 ± 4.54[a]	11.45 ± 0.68[a]
	Interspecific	93.85 ± 7.12[a]	9.52 ± 0.63[a]

Table S2. Allocation of target and neighbouring seedlings among rhizoboxes.

Target species	Treatment	Neighbour species	Neighbour density	Rhizoboxes (n)	Target seedlings (n)	*Cy. glauca* seedlings (n)	*Cu. lanceolata* seedlings (n)	Total seedlings (n)
Cy. glauca	Control	None	0	5	5	5	0	5
Cy. glauca	Intra	*Cy. glauca*	1	5	5	10	0	10
Cy. glauca	Intra	*Cy. glauca*	3	5	5	20	0	20
Cy. glauca	Inter	*Cu. lanceolata*	1	5	5	5	5	10
Cy. glauca	Inter	*Cu. lanceolata*	3	5	5	5	15	20
Cu. lanceolata	Control	None	0	5	5	0	5	5
Cu. lanceolata	Intra	*Cu. lanceolata*	1	5	5	0	10	10
Cu. lanceolata	Intra	*Cu. lanceolata*	3	5	5	0	20	20
Cu. lanceolata	Inter	*Cy. glauca*	1	5	5	5	5	10
Cu. lanceolata	Inter	*Cy. glauca*	3	5	5	15	5	20
Total				50	50	65	65	130

Table S3. Initial physicochemical properties of the mixed growth substrate. Values are presented as means ± standard deviation (SD).

Variable	Value
pH	7.96 ± 0.1
Soil organic matter (g/kg)	41.39 ± 4.06
Soil organic carbon (g/kg)	24.01 ± 2.35
Total nitrogen (g/kg)	1.44 ± 0.08
Ammonium nitrogen (mg/kg)	6.17 ± 1.23
Nitrate nitrogen (mg/kg)	1.83 ± 1.45
Total phosphorus (g/kg)	0.38 ± 0.01
Available phosphorus (mg/kg)	22.03 ± 1.48
Total potassium (g/kg)	15.41 ± 0.22
Available potassium (mg/kg)	171.44 ± 3.38
Slowly available potassium (mg/kg)	516.1 ± 14.29

Table S4. Overall and species-specific ANOVA results for the effects of competition on root length and total temporal variation in root length.

Species	Variable	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Total	Root length	2	1352754605	676377302	148.35	<0.05
Total	Root length	1602	7304232829	4559446		
Cy glauca	Root length	2	55331376	27665688	23.33	<0.05
Cy glauca	Root length	814	965263241	1185827		
Cu lanceolata	Root length	2	1956526621	978263310	186.05	<0.05
Cu lanceolata	Root length	785	4127613190	5258106		
Total	Variation of root length	2	1	0	3.97	<0.05
Total	Variation of root length	27	3	0		
Cy glauca	Variation of root length	2	1	0	5.41	<0.05
Cy glauca	Variation of root length	12	1	0		
Cu lanceolata	Variation of root length	2	0	0	5.74	<0.05
Cu lanceolata	Variation of root length	12	0	0		

Table S5. Pairwise comparisons of scaled root length between weak and strong neighbor-density levels within each competition type.

Species	Competition	Estimate	*SE*	df	CI	*t*.ratio	*p* value
Cy. glauca	Intra	−0.0054	0.175	18.8	(-0.5328, 0.5220)	−0.031	> 0.05
Cy. glauca	Inter	−0.2640	0.187	19.1	(-0.8246, 0.2970)	−1.415	> 0.05
Cu. lanceolata	Intra	−0.0485	0.305	18.1	(-0.9716, 0.8750)	−0.159	> 0.05
Cu. lanceolata	Inter	−0.3331	0.352	17.9	(-1.3973, 0.7310)	−0.947	> 0.05

Table S6. Species-specific effects of competition on seedling-level residual temporal variation in log-transformed root length after accounting for species-, treatment-, and observation date-specific mean trajectories. Note: Ratios are exponentiated treatment-versus-control contrasts. Higher residual temporal variation under competition was indicated when values higher than 1. *p* values were adjusted using Dunnett's method within each species.

Model component	**Species**	**Contrast**	**Residual SD ratio**	**95% CI**	***t***	***p* value**
Species×treatment	Both species				$F_{2,41} = 37.95$	< 0.05
Treatment	*Cy. glauca*	Intra-control	0.27	0.18-0.40	-7.56	< 0.05
Treatment	*Cy. glauca*	Inter-control	0.48	0.32-0.71	-4.22	< 0.05
Treatment	*Cu. lanceolata*	Intra-control	2.26	1.52-3.37	4.72	< 0.05
Treatment	*Cu. lanceolata*	Inter-control	2.23	1.47-3.37	4.45	< 0.05

Table S7. Longitudinal mixed-effects analysis of temporal variation in root length.

Effect	Num df	Den df	F value	*p* value
Intercept	1	1534	8056.17	<0.05
Species	1	41	78.37	<0.05
Competition	2	41	26.62	<0.05
Time	4	1534	30.96	<0.05
Species × Competition	2	41	6.87	<0.05
Species × Time	4	1534	20.42	<0.05
Competition × Time	8	1534	3.88	<0.05
Species × Competition × Time	8	1534	3.49	<0.05