Appendix

Comparison of fertilizer effect between experiments

To evaluate how fertilization in this experiment performed compared to the treatments in a previous independent experiment with container-grown Japanese larch (Agathokleous et al. 2020), which was executed using a similar protocol, the stem height and aboveground biomass were compared between experiments for each fertilizer treatment. Although the HF treatment was same in the two experiments (2 g per seedling), the fertilizer in the LF treatment (1 g per seedling) was two times higher than in the present experiment (0.5 g per seedlings). The results revealed no evidence for significant differences in stem height (F = 2.87, p = 0.098) and aboveground biomass (F = 3.12, p = 0.085) between the two experiments for LF-treated seedlings. However, stem height (F = 7.07, p = 0.012) and aboveground biomass (F = 12.38, p = 0.001) of HF-treated seedlings were 2.3 (δ = 2.07, CI: 0.09–2.53) and 6.4 (δ = 2.60, CI: 2.312.69) times larger in the present experiment than in the previous experiment, effects that were large in magnitude and practically significant.

Agathokleous E, Kitao M, Komatsu M, Tamai Y, Saito H, Harayama H, Uemura A, Tobita H, Koike T (2020) Effects of soil nutrient availability and ozone on container-grown Japanese larch seedlings and role of soil microbes. J Forestry Res 31, 2295–2311. https://doi.org/10.1007/s11676-019-01056-y

Characteristics of the coco peat used (according to the manufacturer)

Moisture: 19.13%
Total nitrogen (N): 1.21%
Total phosphate (P_2O_5): 0.07%
Total potash (K_2O): 0.41%
Organic matter (loss on ignition): 75.56%
Organic carbon (C): 41.39%
Carbon to nitrogen ratio (C/N): 34
Cation exchange capacity: 151.0 meq/100g
Electrical conductivity (dry matter equivalent 1:10 water, 25°C): 0.28 dS/m
pH (dry matter equivalent 1:10 water, 26°C): 4.9
Corrosive acid: 35.64%
Corrosive acid content in organic matter: 47.17%

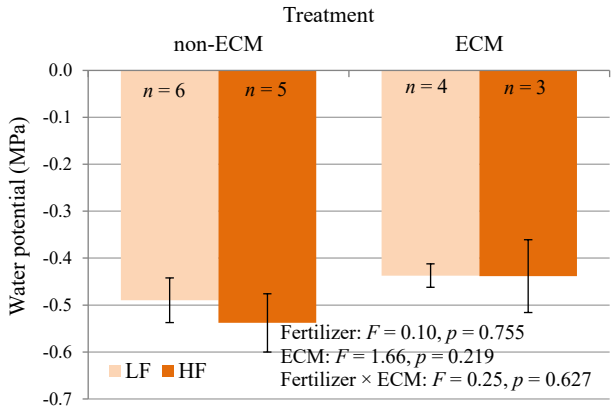

Fig. S1 Means ± standard error of branch water potential in Japanese larch seedlings sampled approximately 1.5 month following inoculation and 2.5 months after fertilization (pre-drought assessment). ECM, inoculation with ectomycorrhizae; 15-9-11+2MgO+TE treatments: LF, 0.5 g (low-dose fertilization); HF, 2 g (high-dose fertilization). Data were analyzed with a generalized linear model (GLM) at α = 0.05. n = sample size for each experimental condition.

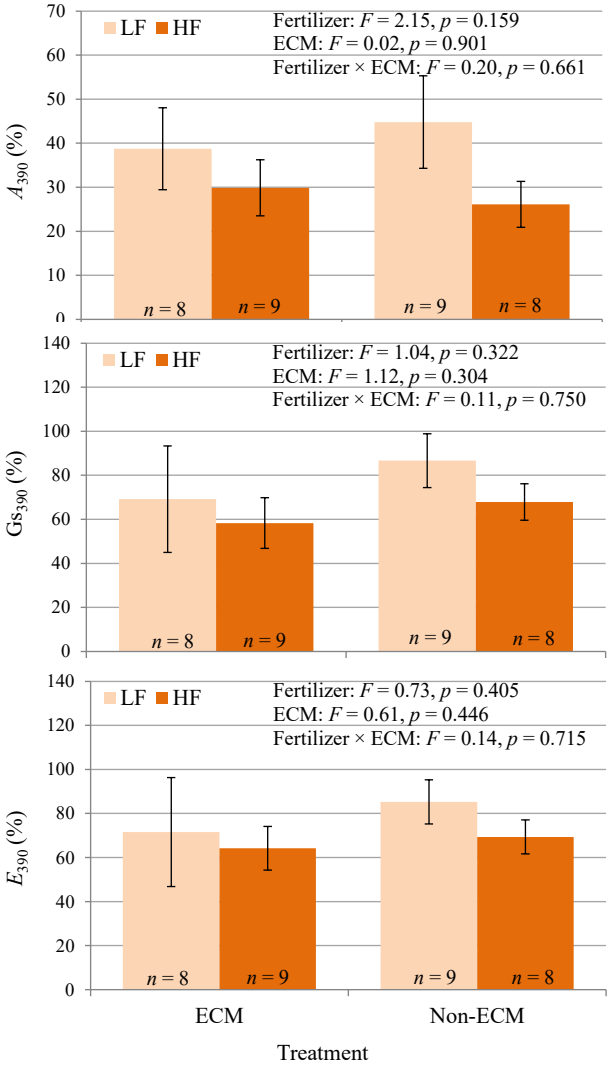

Fig. S2 Means ± standard error of light response variables in Japanese larch seedlings analyzed approximately 1.5 month after inoculation and 2.5 months after fertilization (pre-drought assessment). A_{390}, net photosynthetic rate; Gs_{390}, stomatal conductance, and E_{390}, transpiration rate. ECM, inoculation with ectomycorrhizae; 15-9-11+2MgO+TE treatments: LF 0.5 g (low-dose fertilization); HF, 2 g (high-dose fertilization). Values are percentage of change in status recorded at 100 µmol m^{-2} s^{-1} relative to those recorded at 1500 µmol m^{-2} s^{-1} 15 min earlier. Data were analyzed with a generalized linear model (GLM) at $\alpha = 0.05$. n = sample size.

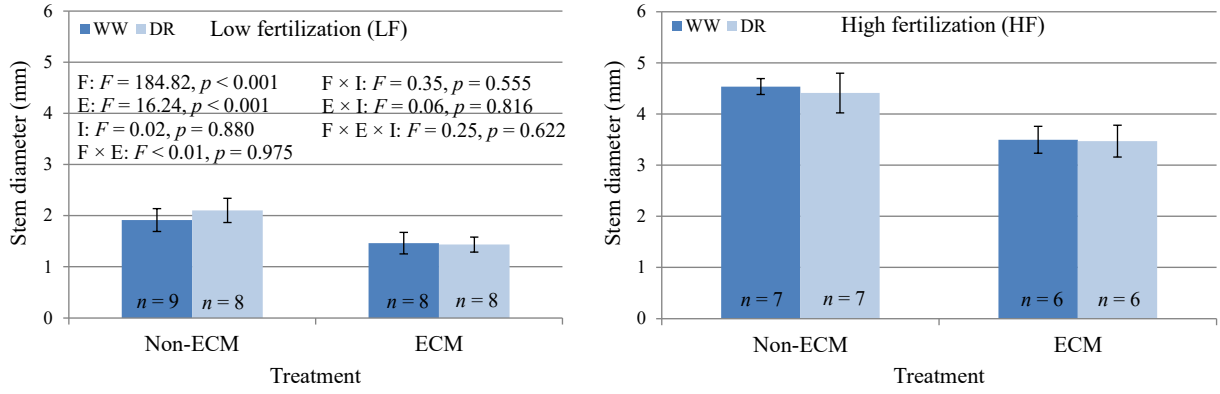

Fig. S3 Means ± standard error of stem diameter of Japanese larch seedlings evaluated approximately 5, 4, and 1.5 months after fertilization, ECM, and irrigation treatments, respectively (final assessment). ECM stands for inoculation with ectomycorrhizae. WW stands for well-watered (500 mL weekly) plants whereas DR stands for drought-subjected plants (50 mL weekly); 15-9-11+2MgO+TE treatments: LF 0.5 g (low-dose fertilization); HF, 2 g (high-dose fertilization) 15-9-11+2MgO+TE fertilizer. Single letters F, E, and I (in non-italics) indicate Fertilizer, ECM, and Irrigation factors. Data were analyzed with a generalized linear model (GLM) at α=0.05. n = sample size.

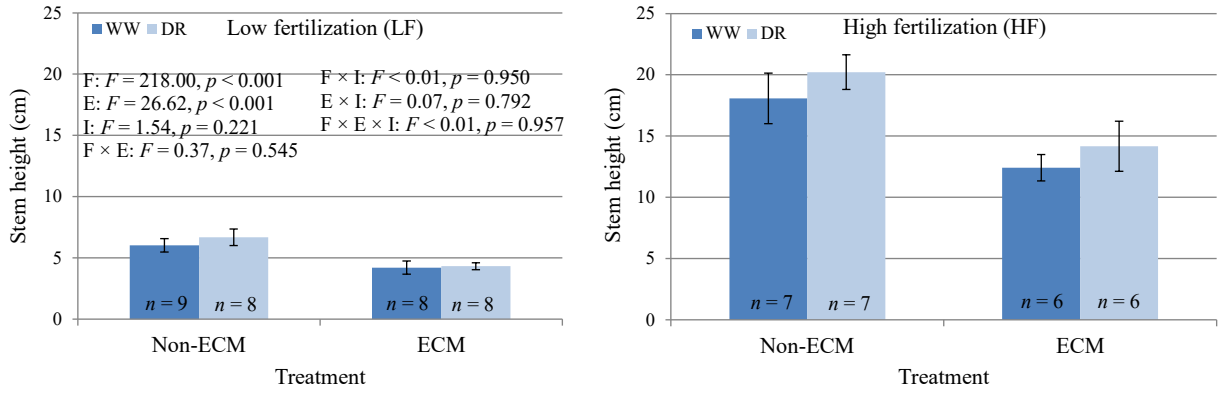

Fig. S4 Means ± standard error of stem height of Japanese larch seedlings evaluated approximately 5, 4, and 1.5 months after fertilization, ECM, and irrigation treatments, respectively (final assessment). ECM, inoculation with ectomycorrhizae; WW, well-watered (500 mL weekly); DR, drought treatment (50 mL weekly); 15-9-11+2MgO+TE treatments: LF 0.5 g (low-dose fertilization); HF, 2 g (high-dose fertilization); factors: F, fertilizer; E, ECM; I, irrigation. Data were analyzed with a generalized linear model (GLM) at α = 0.05. n = sample size.

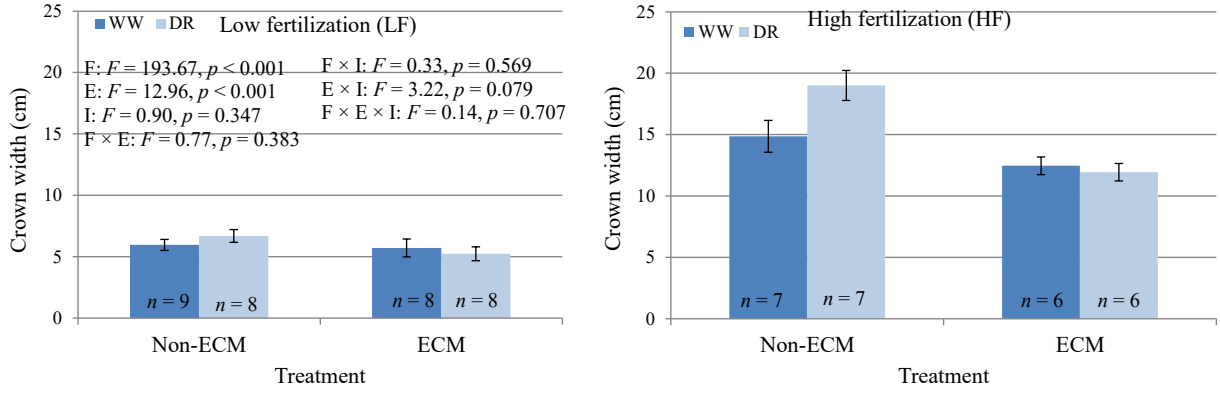

Fig. S5 Means ± standard error of crown width of Japanese larch seedlings evaluated approximately 5, 4, and 1.5 months after fertilization, ECM, and irrigation treatments, respectively (final assessment). ECM, inoculation with ectomycorrhizae; WW, well-watered (500 mL weekly); 15-9-11+2MgO+TE treatments: LF 0.5 g (low-dose fertilization); HF, 2 g (high-dose fertilization); factors: F, fertilizer; E, ECM; I, irrigation factors. Data were analyzed with a generalized linear model (GLM) at α = 0.05. n = sample size.

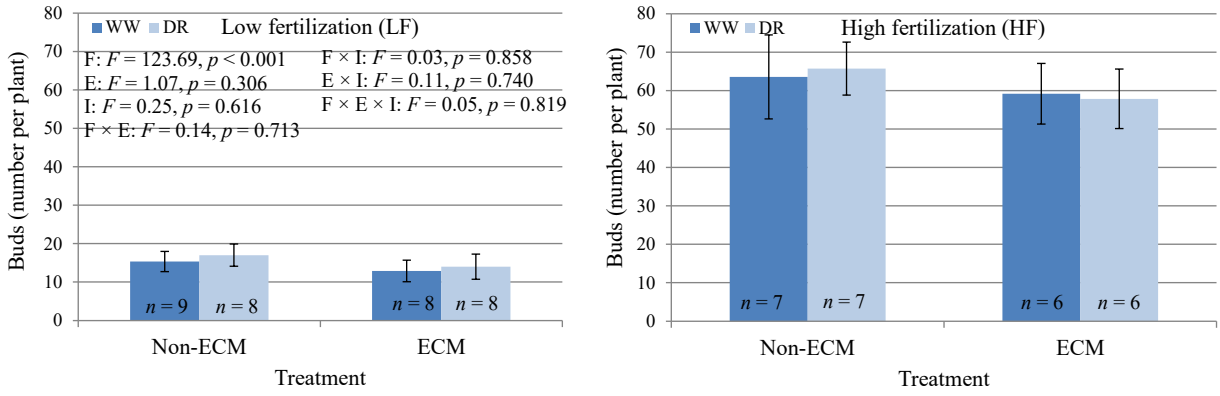

Fig. S6 Means ± standard error of the number of buds of Japanese larch seedlings evaluated approximately 5, 4, and 1.5 months after fertilization, ECM, and irrigation treatments, respectively (final assessment). ECM, inoculation with ectomycorrhizae; WW, well-watered (500 mL weekly); 15-9-11+2MgO+TE treatments: LF 0.5 g (low-dose fertilization); HF, 2 g (high-dose fertilization); factors: F, fertilizer; E, ECM; I, irrigation factors. Data were analyzed with a generalized linear model (GLM) at $\alpha = 0.05$. n = sample size.

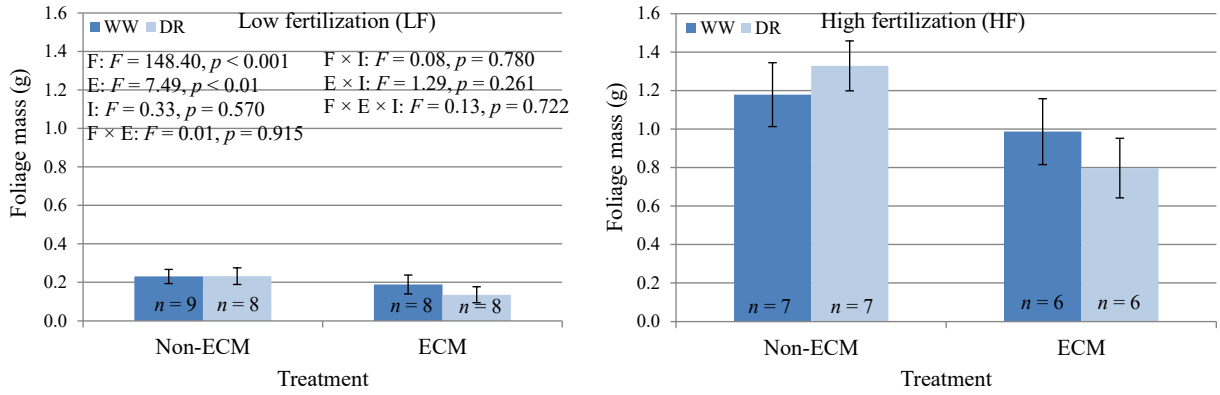

Fig. S7 Means ± standard error of foliage mass of Japanese larch seedlings evaluated approximately 5, 4, and 1.5 months after fertilization, ECM, and irrigation treatments, respectively (final assessment). ECM, inoculation with ectomycorrhizae; WW, well-watered (500 mL weekly); 15-9-11+2MgO+TE treatments: LF 0.5 g (low-dose fertilization); HF, 2 g (high-dose fertilization); factors: F, fertilizer; E, ECM; I, irrigation factors. Data were analyzed with a generalized linear model (GLM) at $\alpha = 0.05$. n = sample size.

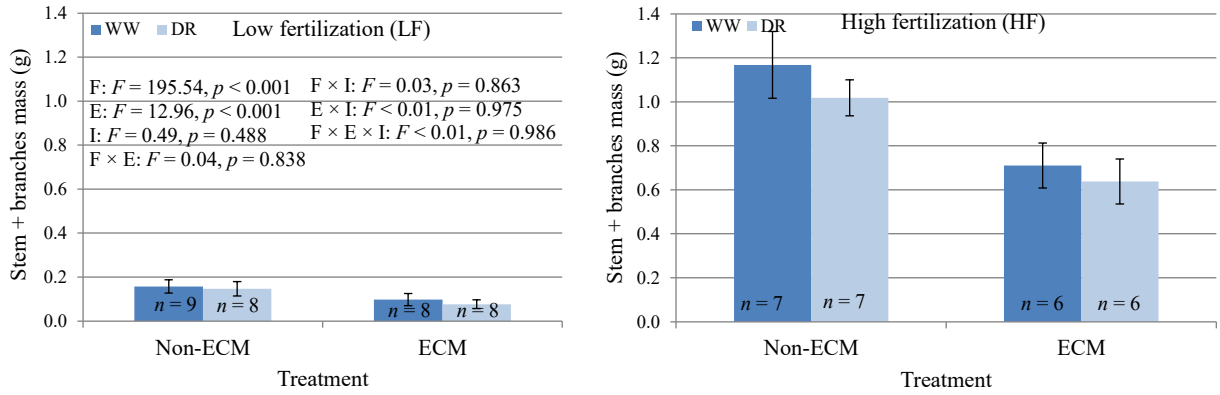

Fig. S8 Means ± standard error of stem + branches mass of Japanese larch seedlings evaluated approximately 5, 4, and 1.5 months after fertilization, ECM, and irrigation treatments, respectively (final assessment). ECM, inoculation with ectomycorrhizae; WW, well-watered (500 mL weekly); 15-9-11+2MgO+TE treatments: LF 0.5 g (low-dose fertilization); HF, 2 g (high-dose fertilization); factors: F, fertilizer; E, ECM; I, irrigation factors. Data were analyzed with a generalized linear model (GLM) at $\alpha = 0.05$. n = sample size.

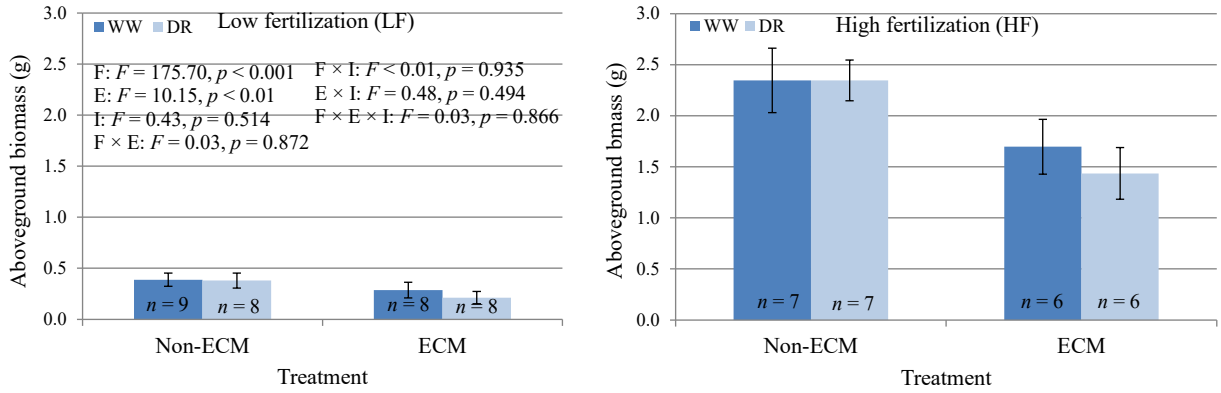

Fig. S9 Means ± standard error of aboveground biomass of Japanese larch seedlings evaluated approximately 5, 4, and 1.5 months after fertilization, ECM, and irrigation treatments, respectively (final assessment). ECM, inoculation with ectomycorrhizae; WW, well-watered (500 mL weekly);; 15-9-11+2MgO+TE treatments: LF 0.5 g (low-dose fertilization); HF, 2 g (high-dose fertilization); factors: F, fertilizer; E, ECM; I, irrigation factors. Data were analyzed with a generalized linear model (GLM) at $\alpha = 0.05$. n = sample size.

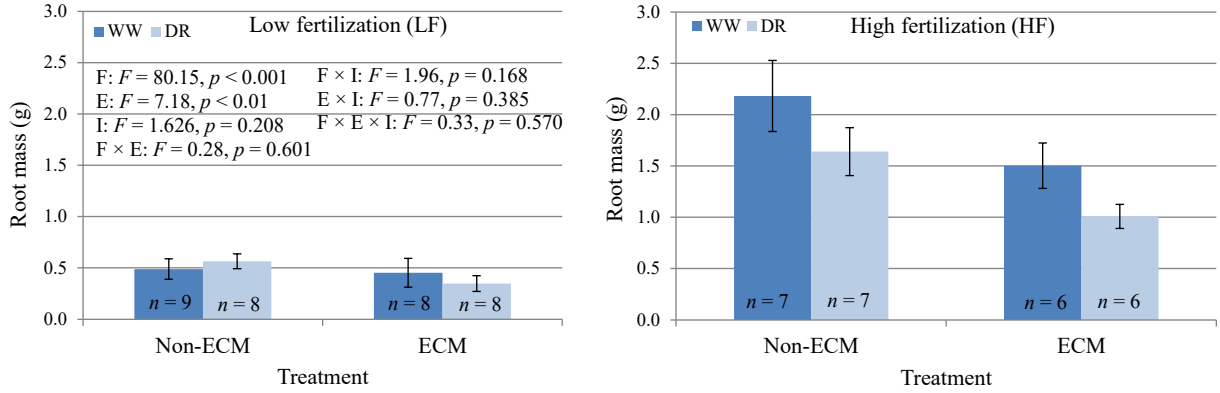

Fig. S10 Means ± standard error of root mass of Japanese larch seedlings evaluated approximately 5, 4, and 1.5 months after fertilization, ECM, and irrigation treatments, respectively (final assessment). ECM, inoculation with ectomycorrhizae; WW, well-watered (500 mL weekly); 15-9-11+2MgO+TE treatments: LF 0.5 g (low-dose fertilization); HF, 2 g (high-dose fertilization); factors: F, fertilizer; E, ECM; I, irrigation factors. Data were analyzed with a generalized linear model (GLM) at $\alpha = 0.05$. n = sample size.

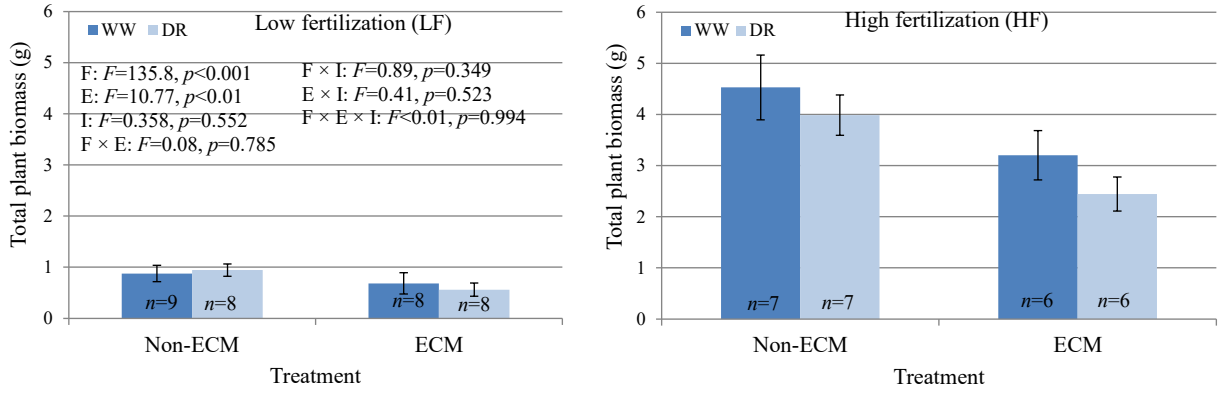

Fig. S11 Means ± standard error of total plant biomass of Japanese larch seedlings evaluated approximately 5, 4, and 1.5 months after fertilization, ECM, and irrigation treatments, respectively (final assessment). ECM, inoculation with ectomycorrhizae; WW, well-watered (500 mL weekly); 15-9-11+2MgO+TE treatments: LF 0.5 g (low-dose fertilization); HF, 2 g (high-dose fertilization); factors: F, fertilizer; E, ECM; I, irrigation factors. Data were analyzed with a generalized linear model (GLM) at $\alpha = 0.05$. n = sample size.

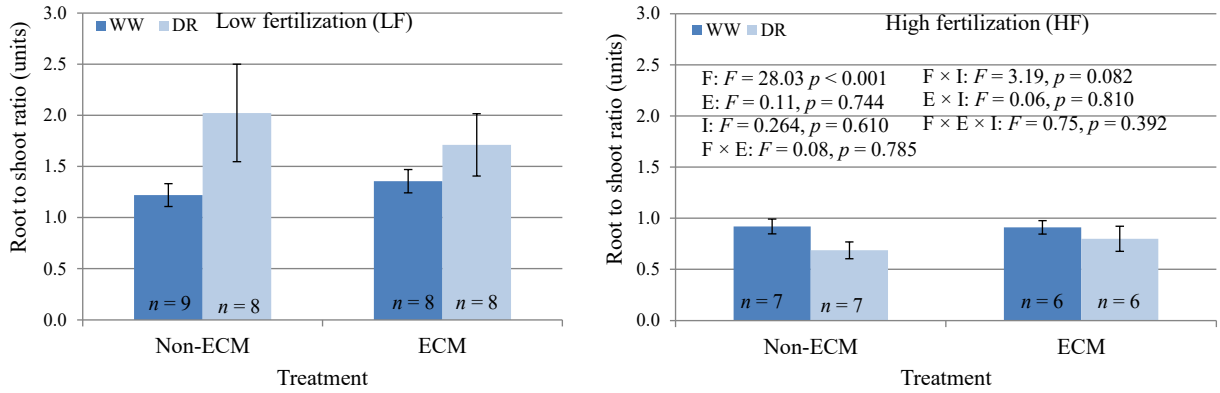

Fig. S12 Means ± standard error of root to shoot ratio of Japanese larch seedlings evaluated approximately 5, 4, and 1.5 months after fertilization, ECM, and irrigation treatments, respectively (final assessment). ECM, inoculation with ectomycorrhizae; WW, well-watered (500 mL weekly); 15-9-11+2MgO+TE treatments: LF 0.5 g (low-dose fertilization); HF, 2 g (high-dose fertilization); factors: F, fertilizer; E, ECM; I, irrigation factors. Data were analyzed with a generalized linear model (GLM) at $\alpha = 0.05$. n = sample size.

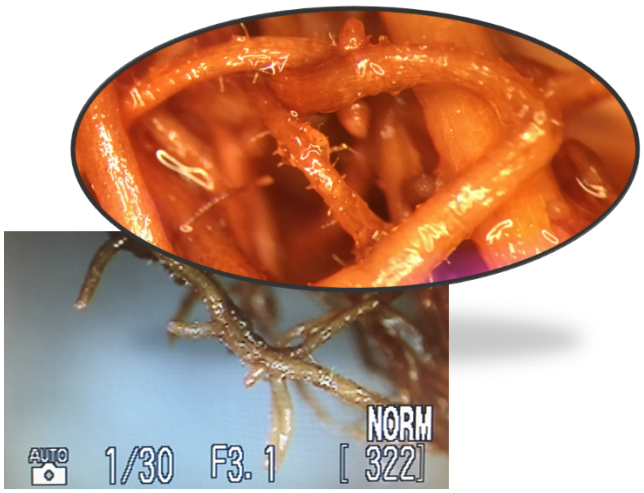

Fig. S13 Stereomicrograph of roots of Japanese larch seedlings at the end of the experiment. Seedlings were treated with 2 g (high-dose fertilization) 15-9-11+2MgO+TE fertilizer (HF), sterilized water (no-inoculation of ectomycorrhizae (non-ECM), and weekly irrigation of 500 mL of water (well-watered, WW). The upper photo represents magnification such that the root hair is observable.

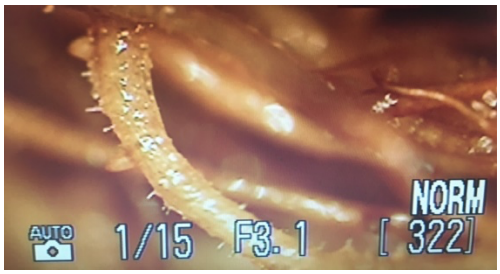

Fig. S14 Stereomicrograph of roots of Japanese larch seedlings at the end of the experiment. Seedlings were treated with 2 g (high-dose fertilization) 15-9-11+2MgO+TE fertilizer (HF), sterilized water (no-inoculation of ectomycorrhizae (non-ECM), and weekly irrigation of 50 mL of water (drought, DR).

Fig. S15 Stereomicrograph of roots of Japanese larch seedlings at the end of the experiment. Seedlings were treated with 2 g (high-dose fertilization) 15-9-11+2MgO+TE fertilizer (HF), inoculation of ectomycorrhizae (ECM), and weekly irrigation of 50 mL of water (drought, DR).

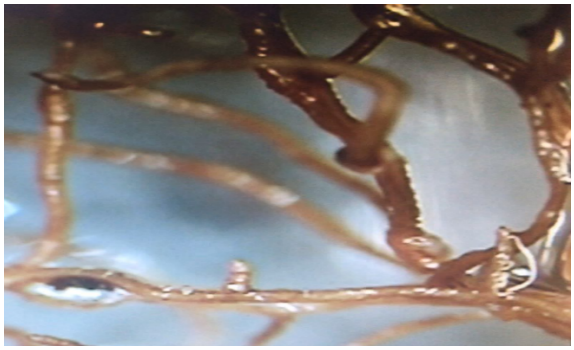

Fig. S16 Stereomicrograph of roots of Japanese larch seedlings at the end of the experiment. Seedlings were treated with 0.5 g (low-dose fertilization) 15-9-11+2MgO+TE fertilizer (LF), inoculation of ectomycorrhizae (ECM), and weekly irrigation of 50 mL of water (drought, DR).

Fig. S17. Stereomicrograph of roots of Japanese larch seedlings at the end of the experiment. Seedlings were treated with 0.5 g (low-dose fertilization) 15-9-11+2MgO+TE fertilizer (LF), sterilized water (no-inoculation of ectomycorrhizae (non-ECM), and weekly irrigation of 50 mL of water (drought, DR).

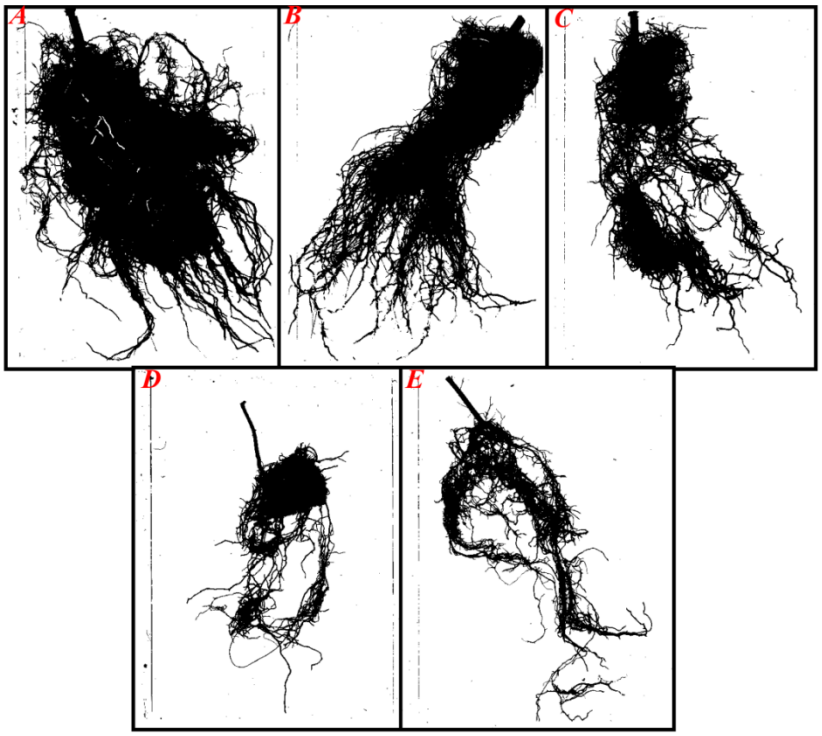

Fig. S18 Roots of Japanese larch seedlings at the end of the experiment. Photographs were taken by scanning the roots in a scanner connected to a computer, under standardized dimensions, and thus the dimensions shown here are same across photos A–E (the size is proportionally reduced for illustration purposes, but the original frame size within which roots were put on the scanner was 14 × 22 cm). The photos were converted to 50% black and white for illustration purposes. Seedlings were treated with 0.5 g (low-dose fertilization) 15-9-11+2MgO+TE fertilizer (LF), sterilized water (no ECM inoculation [non-ECM]), and weekly irrigation with 50 mL of water (drought, DR). Panels A, B, and C show roots of randomly selected HF-treated seedlings; panels D and E show roots of randomly selected LF-treated seedlings. Treatments: (A) HF × non-ECM × WW, (B) HF × non-ECM × DR, (C) HF × ECM × DR, (D) LF × ECM × DR, (E) LF × non-ECM × DR. 15-9-11+2MgO+TE fertilizer treatments: LF, 0.5 g (low-dose fertilization); HF, 2 g (high-dose fertilization). ECM, inoculation with ectomycorrhizae; WW, well-watered (500 mL weekly); DR, drought treatment (50 mL weekly).

Table S1 Cohen's delta (δ) effect size and 95% confidence interval (CI) for different pairs of comparisons between experimental conditions for which the overall main effect of the interaction fertilization × ECM × irrigation was significant based on a generalized linear model (GLM) analysis. These concerned the branch water potential for the final evaluation (see Sect. 3.2 of the main manuscript). The data and results are presented in Fig. 4B of the main manuscript. The comparisons were (1) LF × non-ECM × WW vs LF × non-ECM × DR, (2) LF × ECM × WW vs LF × ECM × DR, (3) LF × on-ECM × WW vs LF×ECM × WW, (4) LF × non-ECM × DR vs LF × ECM × DR, (5) HF × non-ECM × WW vs HF × non-ECM × DR, (6) HF × ECM × WW vs HF × ECM × DR, (7) HF × non-ECM × WW vs HF × ECM × WW, (8) HF × non-ECM × DR vs HF × ECM × DR. ECM, inoculation with ectomycorrhizae; 15-9-11+2MgO+TE fertilizer treatments: LF, 0.5 g (low-dose fertilization); HF, 2 g (high-dose fertilization); WW, well-watered (500 mL weekly) plants; DR, drought treatment (50 mL weekly). n.s = not significant, whereas lack of "n.s." indicates significance ($\alpha = 0.05$, *t*-test).

Comparison	Water potential
LF × non-ECM × WW vs LF × non-ECM × DR	$\delta = -1.25$, CI: –1.35 to –1.19
LF × ECM×WW vs LF × ECM×DR	$\delta = -3.23$, CI: –3.29 to –3.16
LF × non-ECM × WW vs LF×ECM × WW	n.s
LF × non-ECM × DR vs LF × ECM×DR	$\delta = -0.85$, CI: –0.91 to –0.75
HF × non-ECM × WW vs HF × non-ECM × DR	$\delta = -4.17$, CI: –4.23 to –4.14
HF × ECM × WW vs HF × ECM × DR	$\delta = -3.35$, CI: –3.38 to –3.30
HF × non-ECM × WW vs HF × ECM × WW	n.s
HF × non-ECM × DR vs HF × ECM × DR	n.s

Table S2 Results of multiple comparisons (*t*-tests) within Time × Irrigation tested at $\alpha = 0.05$ (see Table S5 for the main GLM results and Fig. 5 in the main manuscript for the data). Gs_{390}, stomatal conductance; E_{390}, transpiration rate. ECM, inoculation with ectomycorrhizae; WW, well-watered (500 mL weekly); DR, drought treatment (50 mL weekly). n.s = nonsignificant at $\alpha = 0.05$, whereas lack of "n.s." indicates significance (*t*-test).

Comparison	Gs_{390}	E_{390}
DR × Time 1 vs. DR × Time 2	$\delta = 1.31$, CI: 1.30–1.31	$\delta = 1.28$, CI: 1.01–1.35
DR × Time 2 vs. DR × Time 3	$\delta = -1.42$, CI: –1.42 to –1.41	$\delta = -1.34$, CI: –1.42 to –1.19
DR × Time 1 vs. DR × Time 3	n.s	n.s
WW × Time 1 vs. WW × Time 2	$\delta = 0.50$, CI: 0.48–0.51	n.s
WW × Time 2 vs. WW × Time 3	n.s	n.s
WW × Time 1 vs. WW × Time 3	n.s	n.s
Time 1 × DR vs. Time 1 × WW	$\delta = -1.79$, CI: –1.81 to –1.78	$\delta = -1.67$, CI: –1.93 to –1.44
Time 2 × DR vs. Time 2 × WW	$\delta = -2.58$, CI: –2.58 to –2.57	$\delta = -2.70$, CI: –2.77 to –2.46
Time 3 × DR vs. Time 3 × WW	$\delta = -2.32$, CI: –2.33 to –2.31	$\delta = -2.31$, CI: –2.46 to –2.09

Table S3 Cohen's delta (δ) effect size and 95% confidence interval (CI) for different pairs of comparisons between experimental conditions for which the overall main effect of the interaction fertilizer × ECM was significant based on a generalized linear model (GLM) analysis. These concerned foliage mass, aboveground biomass, and total plant biomass for the pre-drought evaluation (see Sect. 3.1 of the main manuscript). The data and results are presented in Figs. 2B, 2D, and 2E of the main manuscript. The comparisons were (1) non-ECM × HF vs. non-ECM × LF, (2) ECM × HF vs. ECM × LF, (3) LF × non-ECM vs. LF × ECM, and (4) HF × non-ECM vs. HF × ECM. ECM, inoculation with ectomycorrhizae; 15-9-11+2MgO+TE fertilizer treatments: LF, 0.5 g (low-dose fertilization); HF, 2 g (high-dose fertilization). n.s = not significant, whereas lack of "n.s." indicates significance ($\alpha = 0.05$, *t*-test).

Comparison	Foliage mass	Aboveground biomass	Total plant biomass
non-ECM × HF vs. non-ECM × LF	$\delta = 3.93$, CI: 3.62–4.01	$\delta = 4.30$, CI: 3.91–4.41	$\delta = 4.17$, CI: 3.67–4.36
ECM × HF vs. ECM × LF	$\delta = 2.26$, CI: 2.06–2.35	$\delta = 3.06$, CI: 2.87–3.17	$\delta = 2.80$, CI: 2.52–2.95
LF × non-ECM vs. LF × ECM	n.s.	n.s.	n.s.
HF × non-ECM vs. HF × ECM	$\delta = -2.41$, CI: –2.60 to –2.09	$\delta = -2.67$, CI: –2.86 to –2.29	$\delta = -2.72$, CI: –2.99 to –2.22

Table S4 Cohen's delta (δ) effect size and 95% confidence interval (CI) for different pairs of comparisons between experimental conditions for which the overall main effect of the interaction ECM × Irrigation was significant based on a generalized linear model (GLM) analysis. These concerned the ratio of shed needles mass to all needles mass for the final evaluation (see Sect. 3.2 of the main manuscript). The data and results are presented in Fig. 4A of the main manuscript. The comparisons were (1) ECM × DR vs. ECM × WW, (2) non-ECM × DR vs. non-ECM × WW, (3) DR × ECM vs. DR × non-ECM, and (4) WW × ECM vs. WW × non-ECM. ECM, inoculation with ectomycorrhizae; 15-9-11+2MgO+TE fertilizer treatments: LF, 0.5 g (low-dose fertilization); HF, 2 g (high-dose fertilization). n.s = not significant, whereas lack of "n.s." indicates significance ($\alpha = 0.05$, *t*-test).

Comparison	Shed needles mass to all needles mass
ECM × DR vs. ECM × WW	$\delta = 3.93$, CI: 3.62–4.01
non-ECM × DR vs. non-ECM × WW	n.s.
DR × ECM vs. DR × non-ECM	n.s.
WW × ECM vs. WW × non-ECM	n.s.

Table S5 Results of generalized linear model (GLM) analysis tested at $\alpha = 0.05$ (see Fig. 5 in the main manuscript for the data). A_{390}, net photosynthetic rate; Gs_{390}, stomatal conductance; E_{390}, transpiration rate. ECM, inoculation with ectomycorrhizae; 15-9-11+2MgO+TE fertilizer treatments: LF, 0.5 g (low-dose fertilization); HF, 2 g (high-dose fertilization). Values in red color indicate statistical significance at $\alpha = 0.05$. Regarding time, the results for (1) A_{390}, (2) Gs_{390}, and (3) E_{390} were (1) Time 1 $\neq$ Time 2 $\neq$ Time 3, (2) Time 1 $\neq$ Time 2 = Time 3; (3) Time 1 = Time 3 $\neq$ Time 2 (*t*-test). See Table S2 for the results of multiple comparisons within time × irrigation for A_{390} and Gs_{390}.

Main factor	A390	Gs390	E390
Fertilizer	$F = 3.81$, $p = 0.061$	$F = 11.66$, $p < 0.01$	$F = 11.31$, $p < 0.01$
ECM	$F = 0.08$, $p = 0.776$	$F < 0.01$, $p = 0.980$	$F < 0.01$, $p = 0.997$
Irrigation	$F = 137.82$, $p < 0.01$	$F = 116.04$, $p < 0.001$	$F = 107.04$, $p < 0.001$
Fertilizer × ECM	$F = 2.52$, $p = 0.123$	$F < 0.01$, $p = 0.986$	$F = 0.02$, $p = 0.898$
Fertilizer × Irrigation	$F = 3.75$, $p = 0.063$	$F = 2.32$, $p = 0.139$	$F = 2.11$, $p = 0.157$
ECM × Irrigation	$F < 0.01$, $p = 0.976$	$F<0.01$, $p = 0.952$	$F = 0.02$, $p = 0.890$
Fertilizer × ECM × Irrigation	$F = 1.78$, $p = 0.193$	$F = 0.09$, $p = 763$	$F = 0.19$, $p = 0.663$
Time	$F = 58.38$, $p < 0.001$	$F = 16.06$, $p < 0.001$	$F = 11.51$, $p < 0.001$
Time × Fertilizer	$F = 0.90$, $p = 0.411$	$F = 1.80$, $p = 174$	$F = 1.95$, $p = 0.151$
Time × ECM	$F = 0.03$, $p = 0.968$	$F = 0.46$, $p = 634$	$F = 0.41$, $p = 0.665$
Time × Irrigation	$F = 0.90$, $p = 0.412$	$F = 4.98$, $p < 0.01$	$F = 7.44$, $p < 0.01$
Time × Fertilizer × ECM	$F = 1.10$, $p = 0.340$	$F = 1.83$, $p = 170$	$F = 2.38$, $p = 0.102$
Time × Fertilizer × Irrigation	$F = 0.28$, $p = 0.757$	$F = 0.52$, $p = 597$	$F = 0.62$, $p = 0.540$
Time × ECM × Irrigation	$F = 0.51$, $p = 0.602$	$F = 1.84$, $p = 169$	$F = 1.97$, $p = 0.149$
Time × Fertilizer × ECM × Irrigation	$F = 0.67$, $p = 0.517$	$F = 0.38$, $p = 683$	$F = 0.42$, $p = 0.657$