

Soil Biochar Application: Assessment of the Effects on Soil Water Properties, Plant Physiological Status, and Yield of Super-Intensive Olive Groves under Controlled Irrigation Conditions

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Supplementary material

Figure S1. Representation of linear correlation between soil resistance to penetration and soil moisture (0-5 cm depth).

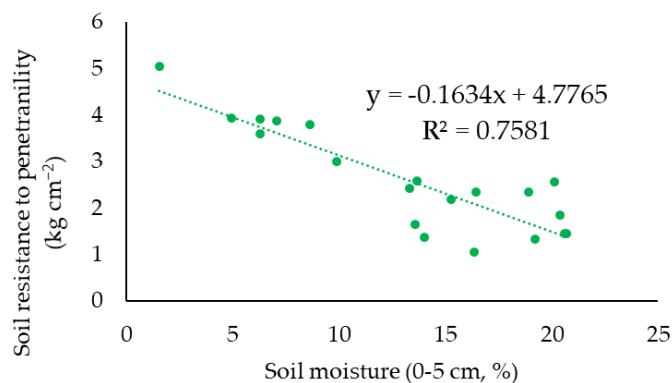
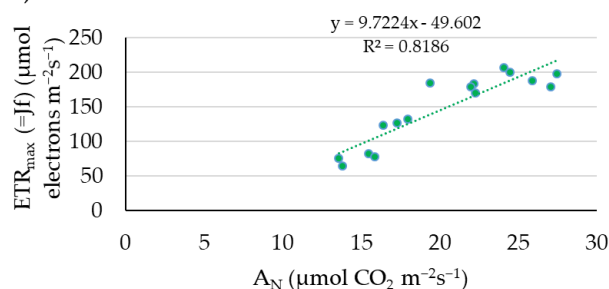


Figure S2. Linear correlations between the maximum electron transport rate (ETR_{max}) and net photosynthetic rate (A_N). (A) All treatments; (B) Correlations per treatment: Control, Olive Biochar+Green compost, Green compost, and Olive Biochar.

(A) All treatments



(B) Per treatment

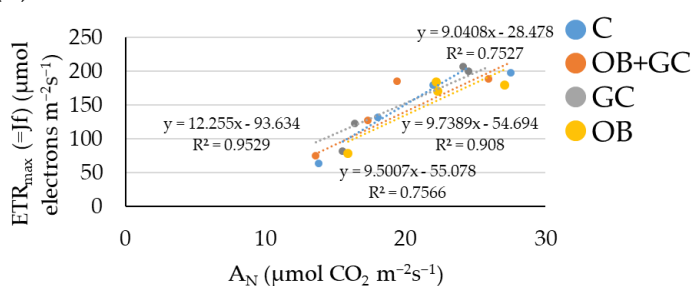


Table S1. Soil moisture and resistance to penetrability (in situ parameters) of not amended and amended soils.

	Sample depth	Day of year	Month	Treatments			
				C	OB+GC	GC	OB
Soil moisture (%)	0-5 cm	104	April	7.1±4.6 ^c	14.0±2.5 ^b	13.6±3.1 ^b	16.3±0.2 ^a
		118	April	13.3±3.6 ^{bc}	16.4±0.2 ^a	13.7±2.4 ^c	15.3±2.4 ^{ab}
		140	May	6.3±8.3 ^a	5.0±4.4 ^a	6.3±8.4 ^a	9.9±7.7 ^a
		159	June	1.6±0.6 ^c	18.9±2.3 ^b	20.1±0.3 ^b	20.4±0.2 ^a
		187	July	8.7±6.4 ^b	20.6±0.1 ^a	20.7±0.1 ^a	19.2±2.7 ^a
		251	September	7.3±7.4 ^c	20.4±0.3 ^b	20.5±0.2 ^b	20.7±0.1 ^a
		260	September	18.9±3.1 ^b	20.1±0.3 ^b	18.6±2.8 ^b	20.4±0.3 ^a
		287	October	16.2±7.7 ^a	20.3±0.4 ^a	20.0±1.1 ^a	18.5±3.6 ^a
		294	October	14.8±4.3 ^b	19.2±1.8 ^a	15.5±4.3 ^b	18.2±2.3 ^{ab}
		334	November	19.1±2.9 ^a	20.3±0.2 ^a	20.2±0.3 ^a	20.2±0.2 ^a
		418	February	11.2±7.9 ^c	12.2±6.9 ^{bc}	17.5±5.3 ^{ab}	18.7±2.6 ^a
	5-10 cm	104	April	13.0±4.6 ^b	16.3±0.2 ^b	16.5±0.2 ^a	16.6±0.1 ^a
		118	April	16.0±1.6 ^a	16.6±0.1 ^a	15.1±2.0 ^b	16.3±1.2 ^a
		140	May	12.7±6.1 ^b	16.1±3.2 ^b	17.2±3.9 ^{ab}	18.3±2.7 ^a
		159	June	4.6±4.9 ^c	18.8±5.5 ^b	20.5±0.1 ^b	20.6±0.1 ^a
		187	July	13.4±5.9 ^c	20.8±0.1 ^b	20.8±0.1 ^b	20.8±0.1 ^a
		251	September	17.5±3.3 ^b	20.7±0.1 ^a	20.7±0.1 ^a	19.3±5.2 ^a
		260	September	20.5±0.3 ^{ab}	20.5±0.1 ^b	20.4±0.2 ^b	20.6±0.1 ^a
		287	October	19.1±3.0 ^a	20.6±0.1 ^a	20.6±0.1 ^a	20.6±0.1 ^a
		294	October	18.8±2.2 ^a	20.4±0.3 ^a	19.1±2.0 ^a	20.3±0.2 ^a
		334	November	20.5±0.2 ^a	20.5±0.1 ^a	20.4±0.1 ^a	20.5±0.1 ^a
		418	February	17.3±3.8 ^a	16.1±4.0 ^a	20.4±0.3 ^a	20.4±0.2 ^a
Resistance to Penetrability (kg cm ⁻²)		104	April	3.9±1.7 ^a	1.4±1.0 ^{bc}	1.7±1.3 ^b	1.1±1.0 ^c
		118	April	2.4±0.8 ^a	2.3±0.6 ^a	2.6±0.6 ^a	2.2±0.4 ^a
		140	May	3.9±0.9 ^a	3.9±0.9 ^a	3.6±1.1 ^a	3.0±0.7 ^b
		159	June	5.1±1.3 ^a	2.3±1.8 ^b	2.6±1.9 ^b	1.9±1.3 ^b
		173	June	3.9±2.0 ^a	2.1±1.0 ^b	2.1±1.2 ^b	1.4±0.8 ^c
		187	July	3.8±2.0 ^a	1.5±1.0 ^b	1.5±0.9 ^b	1.3±0.9 ^b
		251	September	4.3±1.8 ^a	1.3±0.9 ^c	1.7±0.9 ^b	1.2±0.7 ^c
		287	October	3.2±1.8 ^a	1.1±0.7 ^c	1.5±0.8 ^b	1.2±0.7 ^c
		334	November	3.7±1.6 ^a	1.3±0.5 ^c	2.1±0.9 ^b	1.9±0.8 ^{bc}
		418	February	4.7±1.6 ^a	2.0±1.0 ^c	3.7±1.7 ^b	2.6±1.2 ^c

Different letters indicate significant differences between treatments in the same sampling ($p < 0.05$).

C: Control; OB+GC: Olive Biochar+ Green compost; GC: Green Compost; OB: Olive Biochar

Table S2. Physiological parameters measured in olive trees: Net photosynthesis rate (A_N), stomatal conductance (g_s), maximum rate of electron transport (ETR_{max}) and calculated value of intrinsic water-use efficiency (WUE_i) at day of the year 251, 287, 334 and 418.

		Day of year (month)				
		251 (September)	287 (October)	334 (November)	418 (February)	
A_N (μmol CO ₂ m ⁻² s ⁻¹)	C	27.5±4.0 ^a	18.0±3.6 ^b	13.8±2.6 ^a	22.0±3.8 ^{ab}	
	OB+GC	25.9±4.7 ^a	17.3±4.3 ^b	13.6±3.6 ^a	19.4±3.4 ^b	
	GC	24.1±2.2 ^a	16.4±2.8 ^b	15.5±3.0 ^a	24.5±2.1 ^a	
	OB	27.1±5.1 ^a	22.2±2.5 ^a	15.9±1.8 ^a	22.3±4.3 ^{ab}	
g_{s, max} (mol H ₂ O m ⁻² s ⁻¹)	C	0.20±0.04 ^a	0.18±0.07 ^a	0.11±0.03 ^a	0.12±0.03 ^a	
	OB+GC	0.21±0.05 ^a	0.15±0.05 ^{ab}	0.11±0.03 ^a	0.10±0.04 ^a	
	GC	0.20±0.03 ^a	0.19±0.04 ^a	0.12±0.03 ^a	0.11±0.02 ^a	
	OB	0.20±0.04 ^a	0.11±0.02 ^b	0.12±0.03 ^a	0.11±0.03 ^a	
ETR_{max} (=Jf) (μmol electrons m ⁻² s ⁻¹)	C	198±49 ^a	132±50 ^b	64±22 ^a	179±22 ^a	
	OB+GC	188±60 ^a	127±58 ^b	75±18 ^a	185±32 ^a	
	GC	207±20 ^a	123±47 ^b	82±21 ^a	200±19 ^a	
	OB	179±43 ^a	184±22 ^a	78±11 ^a	170±35 ^a	Average
WUE_i	C	138 ^b	100 ^a	125 ^a	183 ^a	137 ^a
	OB+GC	123 ^a	115 ^a	124 ^a	194 ^a	139 ^a
	GC	121 ^a	86 ^a	129 ^a	223 ^b	140 ^a
	OB	136 ^b	202 ^b	133 ^a	203 ^b	168 ^a

Different letters indicate significant differences between treatments in the same sampling ($p < 0.05$)