

## Exploring the potential of biostimulants to optimize lettuce cultivation in coupled and decoupled aquaponics systems: growth performance, functional characteristics and metabolomic analysis

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**Table S1:** The parameters derived from the fast JIP fluorescence induction with their explanations and equations, according to Strasser et al. (2000). The secondary parameters presented in Figure 3 are bolded.

Parameter	Explanation
$F_o = F_{50\mu s}$	The initial value of the fluorescence. This is the first reliable fluorescence value after the illumination
$F_{300\mu s}, F_J, F_I$	The fluorescence values at 300 $\mu s$ , 2ms and 30ms respectively
$F_M$	The maximum value of fluorescence. This is the maximum level of OJIP curve
Area	Area between from fluorescence induction (OJIP) curve to maximal fluorescence $F_M$
$S_m = \text{Area} - F_V$	Normalized total complementary area above the OJIP transient
$F_V = F_M - F_o$	Variable chl fluorescence
$F_V/F_M$	Maximal quantum yield of PSII photochemistry
$M_o = 4 (F_{300\mu s} - F_o)/(F_M - F_o)$	The initial slope (in $ms^{-1}$ ) of relative variable chl fluorescence curve (for $F_o = F_{50\mu s}$ )
$V_J = (F_{2ms} - F_o)/(F_M - F_o)$	Relative variable fluorescence at 2ms - point J of OJIP curve
$V_I = (F_{30ms} - F_o)/(F_M - F_o)$	Relative variable fluorescence at 30ms - point I of OJIP curve
$\phi E_o = ET_o / ABS = \phi P_o \cdot \psi E_o = 1 - F_J / F_M$	Quantum yield of electron transport to intermediate acceptors
$\phi R_o = \phi P_o \cdot \psi E_o \cdot \delta R_o = 1 - F_I / F_M$	Quantum yield of electron transport to final acceptors
$1 - V_I$	Yield of reactive centers of PSI
$1/V_I$	Relative yield of final acceptors $e^-$ of PSI
$ABS/RC = (M_o / V_J) \cdot F_M / (F_M - F_o)$	Absorption flux (for PSII antenna chls) per active reaction center (RC)
$TR_o / RC = M_o / V_J$	Trapped energy flux per active RC
$DI_o / RC = (M_o / V_J) \cdot (F_o / F_V)$	Dissipated energy flux per active RC
$PI_{total} = (RC/ABS) \cdot (\phi P_o / 1 - \phi P_o) \cdot (\psi E_o / 1 - \psi E_o) \cdot (\delta R_o / 1 - \delta R_o)$	Index of total photosynthetic efficiency

**Table S2.** The metabolic profile of lettuce samples of the individual treatments. The analysis of metabolites was performed by GC-MS chromatography. The detected amount of each metabolite was assigned as the relative response (fi) of the compound compared to the adonitol (internal standard). Values represent the average of the four biological replicates. Different letters denote statistically significant differences between treatments ( $p \leq 0.05$ ).

Chemical category	Compound	CAP-BS1	CAP-BS-2	CAP	DCAP-BS1	DCAP-BS2	DCA P	HP-BS1	HP-BS2	HP
Amino acids	Alanine	0,0626a	0,251ab	0,256ab	0,087a	0,126a	0,390b	1,148c	0,173ab	0,161a
	Aspartic acid	0,074abc	0,079bc	0,137d	0,045ab	0,176d	0,204e	0,105c	0,158d	0,035a

	GABA	0,411 a	1,067 e	0,576c	0,821d	0,503b	0,808 d	0,411 a	0,473 b	0,461a b
	Glycine	0,137 abc	0,158 bc	0,039a	0,087a b	0,182c	0,155a bc	0,163 bc	0,278 d	0,143 bc
	Pyroglutamic acid	0,018 a	0,138 ab	0,047a	0,557c	0,288b	0,674c	0,110 ab	0,293 b	0,275 b
	Serine	0,040 a	0,079 ab	0,137a b	0,045a	0,1876 b	0,104a b	0,176 ab	0,118a b	0,036a
	Threonine	0,028 a	0,079 bc	0,046 8a	0,045a	0,049a b	0,152 d	0,054 ab	0,097c	0,218e
	Valine	0,006 a	0,033 ab	0,039a b	0,018a b	0,151fg	0,164 g	0,072 cd	0,127e f	0,096 de
	β-Alanine	0,000 a	0,000 a	0,000a	0,019b	0,241f	0,081 d	0,055 c	0,149e	0,045c
Organic acids	Butyric acid	0,006 a	0,033 ab	0,018a	0,008a	0,142b	0,087a b	0,043 ab	0,113a b	0,098a b
	Citric acid	0,829 e	0,620 d	0,516c	0,177a	0,200a	0,322 b	0,221 a	0,187a	0,150a
	Erythronic acid	0,051 ab	0,079 bc	0,284 d	0,045a	0,154d	0,148 d	0,053 ab	0,092c	0,063a b
	Erythro-Pentonic acid	0,234 ab	0,270 ab	0,058a	0,127a	0,206a b	0,481c	0,144 a	0,362 bc	0,122a
	Fumaric acid	0,902 b	0,079 a	0,124a	0,091a	0,081a	0,291a	0,091 a	0,152a	0,044a
	Gluconic acid	0,718 d	0,304 abc	0,058a	0,185a b	0,171a b	0,559 bcd	0,841 d	0,687c d	0,147a
	Glutaconic acid	0,040 a	0,079 c	0,058a bc	0,045a	0,048a b	0,075 bc	0,084 c	0,151 d	0,035a
	Glyceric acid	32,86 8c	32,48 1c	25,79 4bc	19,265 ab	25,026 bc	24,77 8bc	20,72 0ab	20,15 9ab	13,40 6a
	Isocitric acid	0,372 bcd	0,436 de	0,499e	0,302a b	0,324a bc	0,507e	0,391 cd	0,328a bc	0,275a
	Lactic acid	0,109 a	0,159 ab	0,087a	0,177b	0,154a b	0,150a b	0,188 b	0,295c	0,154a b
	Malic acid	30,16 6ab	38,14 5cd	24,91 1a	35,699 bc	53,092 e	42,09 9d	33,78 5bc	30,30 5ab	25,84 4a
	Malonic acid	0,040 a	0,033 a	0,018a	0,023a	0,117b c	0,073a b	0,053 a	0,147c	0,036a
	Oxalic acid	0,878 b	0,297 a	0,353a	0,177a	0,237a	0,272a	0,732 b	0,360a	0,072a
	Ribonic acid	0,063 a	0,079 ab	0,076a b	0,045a	0,191a b	0,281 b	0,055 a	0,097a b	0,035a
	Succinic acid	1,273 e	0,804 d	0,723 d	0,367a bc	0,480c	0,672 d	0,256 ab	0,416 bc	0,169a
	Tartaric acid	0,040 a	0,079 bc	0,058a b	0,045a	0,150d	0,154 d	0,052 ab	0,097c	0,071a bc
	Threonic acid	0,131 cd	0,159 de	0,137c de	0,083b c	0,052a b	0,180e	0,084 bc	0,106c d	0,011a
Water-soluble Sugars	Arabinose	0,063 ab	0,079 ab	0,058a b	0,023a	0,057a b	0,144c	0,070 ab	0,109 bc	0,035a
	Fructose	108,9 97a	156,8 40d	143,3 01cd	158,09 1d	300,44 8f	131,2 44bc	206,8 60e	118,5 43ab	152,5 33d
	Galactose	5,450 d	5,458 d	1,952a b	1,003a	4,341c	2,882a bc	3,259 bc	7,695e	1,223a b
	Glucose	112,5 48a	149,0 58c	134,7 70bc	151,93 4c	330,74 6e	129,1 90ab	199,4 12d	113,6 47a	139,5 94bc
	Maltose	0,131 b	0,205 b	0,132 b	0,147b	0,340c	0,179 b	0,053 a	0,169 b	0,059a

	Mannose	0,255 b	0,487 e	0,286 b	0,217a	0,375c	0,356c	0,410 d	0,625f	0,198a
	Mannose-6-deoxy	0,898 a	1,402 b	1,387 b	2,002c	1,481b	1,297a b	2,443 d	1,436 b	1,589 bc
	Ribofuranose	0,028 a	0,033 a	0,047a	0,008a	0,151c	0,097 b	0,053 a	0,037a	0,034a
	Ribose	0,269 bc	0,251 bc	0,284c	0,140a	0,254b c	0,358 d	0,218 b	0,265 bc	0,154a
	Sedoheptulos e	0,086 ab	0,079 ab	0,105 b	0,045a	0,084a b	0,079a b	0,085 ab	0,165c	0,059a
	Sucrose	58,77 2c	63,28 4c	88,93 7d	40,147 b	56,510 c	36,87 6ab	34,89 2ab	30,28 7a	31,36 8a
	Tagatofurano se	0,320 bc	0,549 d	0,586 d	0,183a	0,360b c	0,419c	0,251 ab	0,230a b	0,328 bc
	Talopyranose	0,000 a	0,079 c	0,000a	0,045b	0,084c	0,149 d	0,085 c	0,151 d	0,047 b
	Threose	0,040 ab	0,057 b	0,018a	0,045a b	0,101c	0,105c	0,051 ab	0,090c	0,021a
	Xylose	0,103 a	0,158 abc	0,115a	0,088a	0,131a b	0,267c	0,166 abc	0,239 bc	1,226 d
Sugar alcohols	Glycerol	0,623 a	0,988 bc	0,695a	0,880b c	1,987f	1,487e	1,017 c	1,181 d	0,847 b
	meso-Erythritol	0,233 c	0,125 ab	0,116a b	0,061a b	0,092a b	0,098a b	0,086 ab	0,154 bc	0,037a
	Myo-Inositol	8,023 e	8,376 e	8,211e	4,876d	4,712c d	2,837a	4,453 cd	4,377 bc	3,985 b
	Ribitol	0,006 a	0,033 ab	0,036a b	0,029a b	0,152d	0,042a b	0,048 b	0,098c	0,032a b
	Xylitol	0,086 ab	0,079 ab	0,087a b	0,045a	0,119b	0,079a b	0,102 b	0,096a b	0,065a b
Other	Aucubin	0,154 ab	0,091 a	0,077a	0,125a	0,261b	0,187a b	0,168 ab	0,175a b	0,125a
	Phosphoric acid	0,000 a	0,000 a	0,000a	0,282d	0,417e	0,187c	0,121 b	0,150 b	0,200c
	Silanamine	1,062 a	2,114 cd	1,832 b	2,386ef	2,244d e	2,530f	2,260 de	1,907 bc	2,165c de