

The impact of the growing system, fertilization and biostimulants on growth, productivity and quality of lettuce

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Introduction

As a new organic cultivation system, this study aimed to use a rotative drum growing system (RDS) under LED, to compare with an horizontal table system (HTS), under organic management. A RDS can optimize the greenhouse growing surface, provide homogenous growing conditions (hence increasing quality and productivity), reduce labor requirement since automatized^{1,2}. In addition, the management of growing media and fertilizers are major determinants of the agronomic performance of greenhouse crops and of product quality. Moreover, several studies reported that biostimulants can lead to higher productivity by increasing nutrient uptake and plant resilience^{3,4}.

Hypotheses

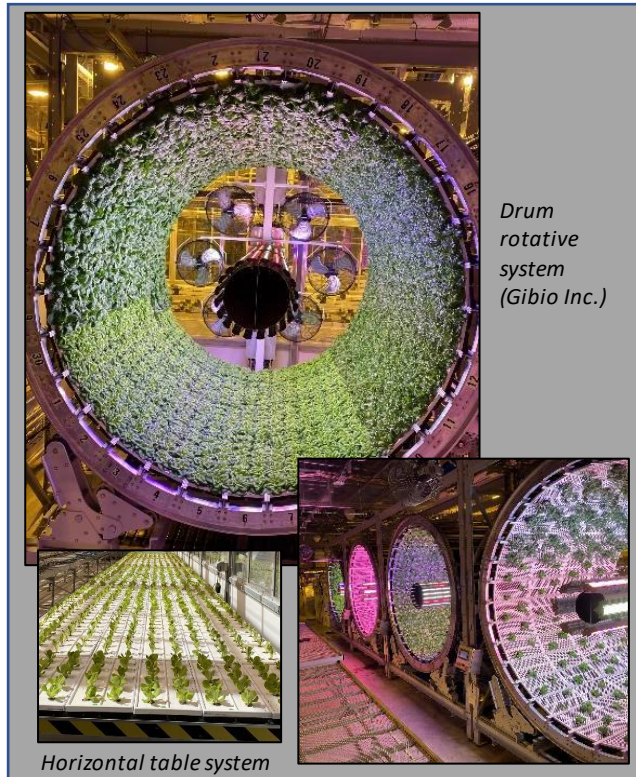
- A RDS will allow a higher and more uniform productivity and quality product compared to the HTS
- Growing media containing wood fibre or coir will increase productivity and quality when compared to a control substrate made of peat alone,
- A vegan-based organic fertilization will perform similarly to an organic animal-based fertilization,
- Wood vinegars used as biostimulants will improve plant production.

Material and methods

Three experiments (I, II, and III) were performed in a greenhouse at Laval University, in collaboration with Gibio Inc., within randomized complete block designs, using 2 systems (rotating drum system, RDS or horizontal table system, HTS) and different treatments. **Exp I:** 24 treatments were tested such as 2 fertilizations (animal- [pelleted poultry manure and feather flour] or vegan-based [soy protein hydrolysate]) x 3 growing media (peat, peat with coir or peat with wood fibre) x 4 biostimulants (1-spruce vinegar applied by drench, 2-or on the leaf, 3-bamboo vinegar applied by drench and 4-water as control) on one cultivar of lettuce (cv Boston).

Exp II and III: 15 treatments were tested such as 3 growing media x 5 lettuce cultivars (cvs Boston, Red Batavia, Romaine, Quarero, Valley heart) in RDS.

Growing media composition	Wood chip		Coco chip	
	Peat	Perlite	Compost	chip
GM: (%)				
Peat	72	18	10	0
Peat/Coir	63	9	10	18
Peat/Wood	63	9	10	18



Drum rotative system (Gibio Inc.)

Horizontal table system

Conclusions

- Lettuce had significantly higher fresh biomass, number of leaves and lower specific leaf area with RDS (rotative drum system) compared to HTS (horizontal table system) (Table 1).
- Lettuces had greater biomass with one or the other growing media depending on experiments (Tables 1, 2).
- Lettuces had greater fresh biomasses, number of leaves and specific leaf area with the animal-based fertilizer than with the vegan (Table 1, Fig. 1).
- The performance index (indicator of chlorophyll sample vitality) was lower with the vegan fertilizer for lettuce grown in peat with coir compared to other treatments (Fig. 1).
- The wood vinegars used as biostimulants had little effect on plant growth parameters (Table 1, Fig. 1).

Results

Table 1. EXP I – Lettuce production in rotative drum system (RDS) or horizontal table (HTS) using different growing media, fertilizers and biostimulants

		Fresh biomass	Number of leaves	Specific leaf area	Performance index (PEA)
		g plant ⁻¹	nb plant ⁻¹	cm ² g ⁻¹ FW	
Experiment I					
System	RDS	51.9 a	41.9 a	258.3 a	2.68
	HTS	40.9 b	30.8 b	348.3 b	3.03
Growing media	Peat with wood fibre	47.4 a	36.8	304.8	3.05
	Peat with coir	44.8 b	36.3	299.8	2.48
Fertilizer	Animal	53.3	38.5 a	309.9 a	3.09
	Vegan	39.5	34.2 b	296.6 b	2.62
Biostimulant	Bamboo vinegar (drench)	45.4	36.8	301.3	3.06
	Spruce vinegar (spray)	46.0	36.2	305.3	2.88
	Spruce vinegar (drench)	47.1	36.3	299.9	2.50
	Control (water)	47.1	36.2	306.5	2.98

ANOVA - P Values

System (S)	*	**	**	NS
Growing media (G)	*	NS	NS	**
S x G	NS	NS	NS	NS
Fertilizer (F)	***	***	**	**
S x F	NS	NS	NS	NS
G x F	NS	NS	NS	*
S x G x F	NS	NS	NS	NS
Biostimulant (B)	NS	NS	NS	NS
S x B	NS	NS	NS	NS
G x B	NS	NS	NS	NS
S x G x B	NS	NS	NS	NS
F x B	*	NS	NS	NS
S x F x B	NS	NS	NS	NS
G x F x B	NS	NS	NS	NS
S x G x F x B	NS	NS	*	NS

Table 2. EXP II and III – Lettuce production in rotative drum system using different growing media

		Fresh biomass	Number of leaves	Leaf area	SPAD Index	Chlorophyll fluorescence (Fv/Fm)	Performance index (PEA)	Height
		g plant ⁻¹	nb plant ⁻¹	cm ² plant ⁻¹				cm
Experiment II								
Growing media	Peat with wood fibre	105.1	b	39.5	1505.2	30.5 b	0.823	1.85
	Peat with coir	119.6	a	41.4	1625.6	35.8 a	0.824	2.00
	Peat	111.1	b	38.8	1504.4	31.8 b	0.837	1.76
Cultivar	Boston	127.2	a	78.3	1929.6	a 23.2 c	0.819	1.56
	Red batavia	131.7	a	18.6	1366.7	b 34.9 b	0.820	1.78
	Romaine	76.9	b	22.7	1338.8	b 40.0 a	0.846	2.27
ANOVA - P Values								
Growing media (G)	**	NS	NS	*	NS	NS	NS	NS
Cultivar (C)	***	***	***	***	NS	*	***	***
G x C	NS	NS	NS	NS	NS	NS	NS	NS
Experiment III								
Growing media	Peat with wood fibre	57.8	a	22.8	1169.7	a 37.4	0.834	1.48
	Peat with coir	57.8	a	22.7	1140.8	a 36.1	0.820	1.41
	Peat	52.1	b	21.5	951.6	b 38.7	0.820	1.55
Cultivar	Quarero	46.7	b	22.6	943.7	b 38.3	0.826	2.42
	Valley heart	65.1	a	22.0	1231.1	a 36.5	0.824	1.41
ANOVA - P Values								
Growing media (G)	NS	NS	*	NS	NS	NS	NS	NS
Cultivar (C)	***	NS	***	NS	NS	NS	*	*
G x C	NS	NS	NS	NS	NS	NS	NS	NS

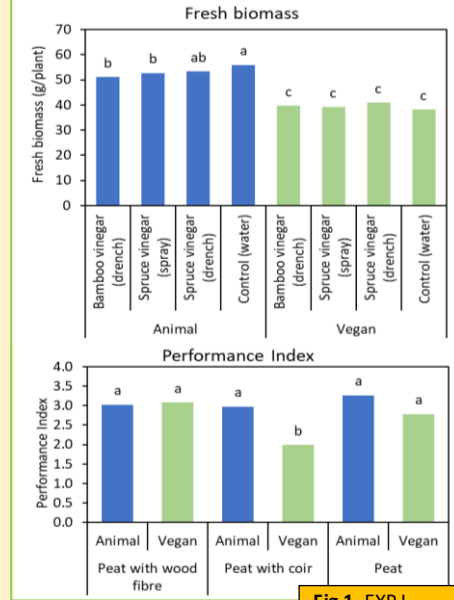


Fig 1. EXP I – Fresh biomass and performance index of lettuce grown in rotative drum system (RDS) or horizontal table (HTS) using different growing media, fertilizers and biostimulants; (on average for both systems)

¹Chow & Chithrameenal 2015. Development of a cylindrical hydroponics system for vertical farming. J. Agric. Sci. Technol. 5:93-100. ²Lin et al. 2013. The effects of red, blue and white light-emitting diodes on the growth, development and edible quality of hydroponically grown lettuce. HortSci. 150: 86-91. ³du Jardin 2015. Plant biostimulants: Definition, concept, main categories and regulation. Sci. Hortic. 196:3-14. ⁴Murphy & Pili 2010. Cultural practices to speed the growth of microgreen arugula. J. Hortic. Sci. Biotechnol. 85:171-176.