12th International SedNet Conference
(online) 28 June – 2 July 2021

Developing pattern in *Prunus laurocerasus* grown on sediment enriched substrates (LIFE SUBSED 17 ENV/IT/000347)

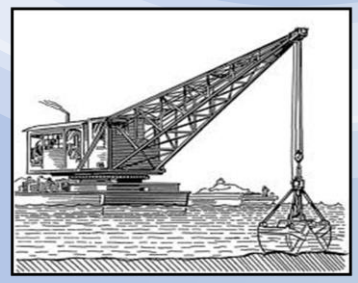
Tozzi F.[1], Turchi A. [1], Antonetti M.[1], Burchi G.[1], Macci C. [2], Peruzzi E. [2], Nin S.[1*]

[1]CREA, Research Centre for Vegetable and Ornamental Crops, Pescia (PT), Italy
[2]ISE-CNR, Institute on Terrestrial Ecosystems – National Research Council of Italy, Pisa (PI), Italy

SEDIMENT TREATMENT

LIFE 17 ENV/IT/000347

DREDGING

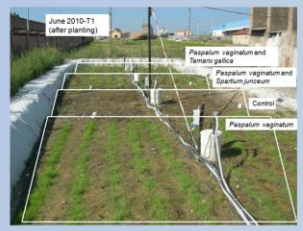


LEGHORN HARBOUR
(43°33'31.78"N,
10°18'29.32"E)

Once a week, for three months, sediments were mechanically turned to:

- ✓homogenize the substrate
- ✓promote aeration
- ✓promote biological activity
- ✓reduce the organic contamination

PHYTOREMEDIATION



AGRIPORT TECHNOLOGY

LANDFARMING

MONITORING
Physical, biochemical and toxicological analysis

- **3 samples(1 m²) at monthly intervals**
- **10 sub-samples**

MATERIALS AND METHODS

LIFE 17 ENV/IT/000347

USED Mixtures and matrixes (v/v)

Mixtures	Peat	Pumice	Coir fiber	Wood fiber	Treated sediment
1. PBS (control)	60	40			0
2. PBS - TS	45	30			25
3. PBS - TS	30	20			50
4. CFBS - TS		30	45		25
5. CFBS - TS		20	30		50
6. WFBS - TS		30		45	25
7. WFBS - TS		20		30	50

PBS – Peat-Based Substrate
CFBS - Coconut Fiber-Based Substrate
WFBS - Wood Fiber-Based Substrate
TS - Treated Sediment

USED MATRIXES

LIFE 17 ENV/IT/000347

STARTING MATERIAL:

cherry laurel rooted cuttings, cultivar ‘Novìta’

Typical and widely used evergreen ornamental and barrier plant (hedge), with a very fast growing and plant development. Nowadays, *P. laurocerasus* is recognised as one of the most commercially important ornamental plant species for the Italian nursery sector.

SUBSTRATE MIXTURES:

LMix 1: 100% PBS (control)
LMix 2: 75% PBS, 25% TS (v/v)
LMix 3: 50% PBS, 50% TS (v/v)
LMix 4: 75% CFBS, 25% TS (v/v)
LMix 5: 50% CFBS, 50% TS (v/v)
LMix 6: 75% WFBS, 25% TS (v/v)
LMix 7: 50% WFBS, 50% TS (v/v)

WATER REGIMES:

WR1: normal
WR2: low (reduced 30%)

EXPERIMENTAL DESIGN:

Totally 336 laurel semi-hardwood cuttings were planted in 8.5-L pots:
4 pots for each combination of 'substrate x water regime' (each one consisting in 2 cuttings), replicated 3 times.

EXPERIMENT PERIOD:

Laurel cuttings were planted at the Azienda Agricola Franceschini (Pescia, Italy) on 08/06/2020 in a greenhouse. The experimental test has been concluded on 31st March 2021.

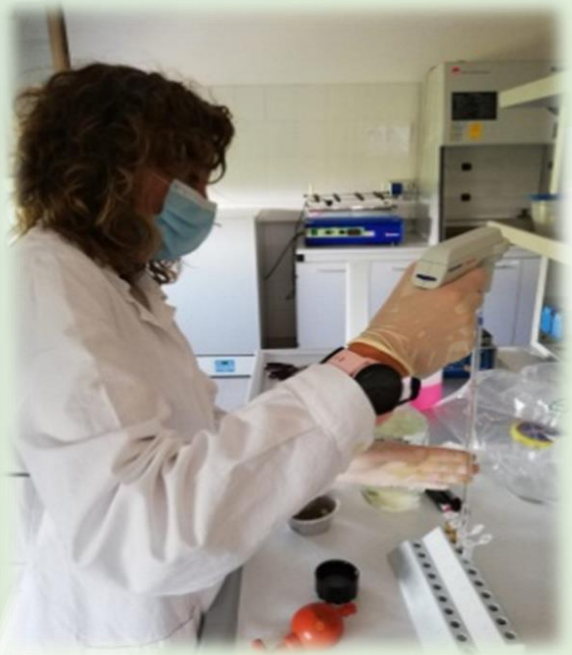
DATA COLLECTION

Non-destructive analysis

- Plant mortality (number; percentage)
- Base stem diameter
- Maximum plant height
- Number of vegetative sprouts
- Length of primary vegetative shoot
- Number of fully expanded leaves on primary vegetative shoot
- Leaf blade colour (L. a. b coordinates) and Chroma index $(a^2 + b^2)^{1/2}$
- Photosynthetic activity by CIRAS-2

Destructive analysis

- Leaf area
- Chlorophyll content
- Fresh and dry weight of the whole plant
- Fresh and dry weight of stem (aerial part)
- Fresh and dry weight of root system
- Malondialdehyde (MDA) analysis for oxidative stress
- Heavy metal analysis (on going)



Physicochemical characteristics	LMix 1	Lmix 2	LMix 3	LMix 4	LMix 5	LMix 6	LMix 7	L.D. 75/2010	L.D. 152/2006
Dry bulk density (g cm^{-3})	0.31	0.54	0.61	0.49	0.63	0.45	0.68	≤ 0.95	n.a
Porosity (%)	87	78	76	80	75	81	72	n.a	n.a
Air capacity (%)	50	28	27	17	17	38	21	n.a	n.a
Water capacity (%)	36	50	48	63	58	44	51	n.a	n.a
Easy available water (%)	4.1	8.0	9.5	11.9	11.3	9.8	8.8	n.a	n.a
Electrical conductivity (dS m^{-1})	0.15	0.41	0.36	0.40	0.40	0.20	0.19	≤ 1.0	n.a
pH	4.6	6.5	6.7	7.4	7.7	7.9	8.0	4.5-8.5	n.a
N-NH3 (mg Kg^{-1})	11.4	8.5	6.7	4.9	1.5	1.3	0.7	n.a	n.a
N-NO3(mg Kg^{-1})	42.9	36.3	28.5	49.6	38.7	85.5	73.1	n.a	n.a
Humidity	5.45	3.63	2.93	4.30	3.33	2.95	2.55	n.a	n.a
Total nitrogen (%)	0.63	0.18	0.14	0.21	0.17	0.33	0.18	n.a	n.a
Total organic carbon (%)	7.96	5.41	**3.52**	7.41	5.68	10.85	4.86	≥ 4	n.a
Phosphorus (g Kg^{-1})	302	354	389	379	388	434	415	n.a	n.a
Metals									
Ca (g Kg^{-1})	4.8	22.5	25.7	18.0	21.6	22.1	25.0	n.a	n.a
Mg (g Kg^{-1})	2.0	5.0	5.1	4.3	5.0	4.9	5.2	n.a	n.a
K (g Kg^{-1})	5.7	3.6	3.0	3.9	3.0	3.4	2.6	n.a	n.a
Fe (g Kg^{-1})	5.0	13.9	15.1	12.3	14.9	13.9	15.7	n.a	n.a
Cu (mg Kg^{-1})	12.1	37.6	40.8	33.3	39.4	38.1	45.2	≤ 230	≤ 120
Zn (mg Kg^{-1})	18.1	136.7	**150.4**	114.6	**143.0**	133.6	**181.3**	≤500	≤ 150
Mn (mg Kg^{-1})	176.6	248.8	278.2	221.9	264.0	253.1	276.5	n.a	n.a
Ni (mg Kg^{-1})	6.5	36.1	37.6	30.0	37.0	34.2	38.6	≤ 100	≤ 120
Cr (mg Kg^{-1})	5.2	44.7	40.7	32.3	42.9	41.4	41.2	n.a	≤ 150
Pb (mg Kg^{-1})	20.6	40.1	43.1	33.0	43.1	38.1	47.4	≤ 140	≤ 100
Cd (mg Kg^{-1})	-	-	-	-	-	-	-	≤ 1.5	≤ 2
Germination index (%)	98.3	83.5	103.6	94.5	70.7	74.5	86.9	n.a	n.a

- Physico-chemical properties in compliance with Legislative Decree 75/2010 regarding fertilizers
- Contamination limits set by Legislative Decree 152/2006 regarding soil requirements

(UNI EN ISO 3696)

RESULTS

LIFE 17 ENV/IT/000347

Significance of single and combined effects of factors for the studied parameters (2020)

Factor/Parameter	BSD	MPH	NVS	LVS	NEL
Substrate	ns	**	**	**	**
Water regime	ns	ns	ns	ns	ns
Substrate * water regime	ns	ns	ns	ns	ns

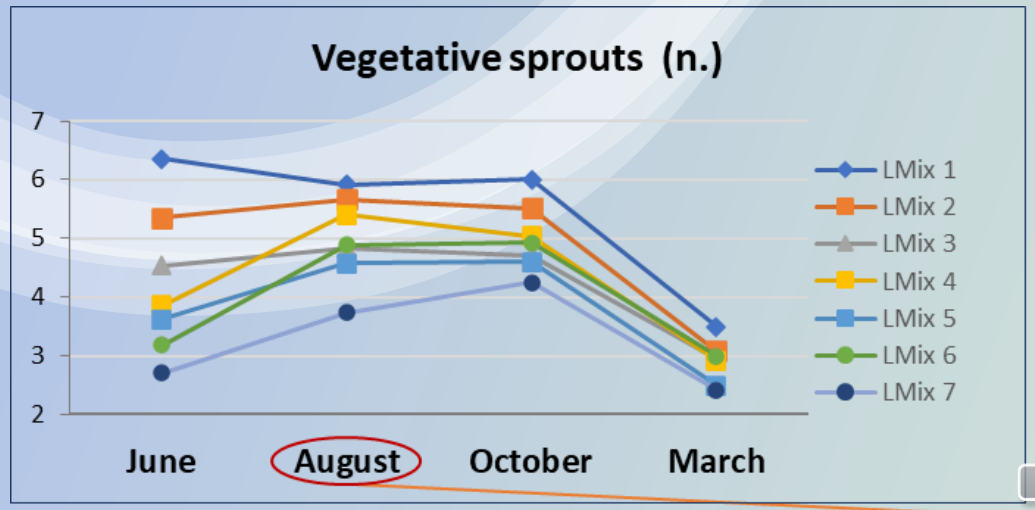
ns = non-significant
* significant for p < 0.05
** significant for p < 0.01

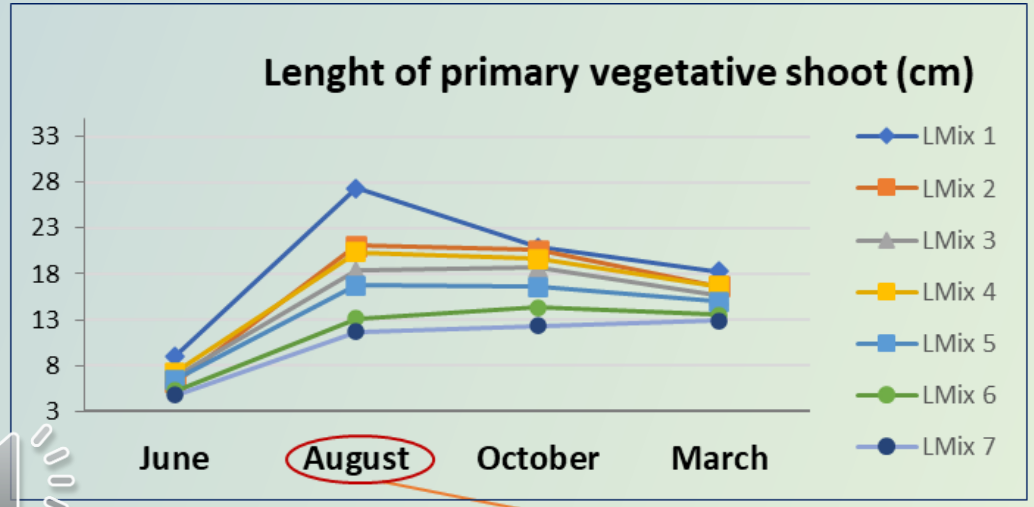
Legend: BSD = Base stem diameter; MPH = Maximum plant height; NVS = Number of vegetative sprouts; LVS = Length of vegetative sprouts; NEL = Number of fully expanded leaves on vegetative sprouts

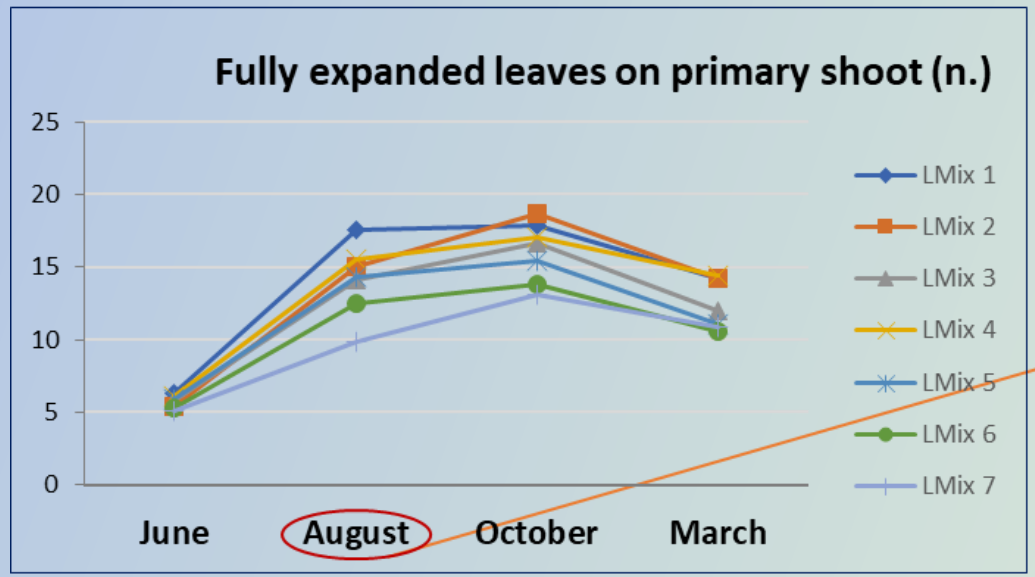
Mean separation within columns by Duncan's multiple range test (p < 0.01)

Factor/Parameter Substrate	MPH	NVS	LVS	NEL
LMix 1	38.5 a	6.2 a	20.8 a	14.2 a
LMix 2	36.1 ab	5.3 b	17.2 b	13.7 ab
LMix 3	33.5 b	4.6 c	15.7 bc	12.7 ab
LMix 4	36.3 ab	4.7 bc	16.9 b	13.4 ab
LMix 5	31.1 c	4.3 c	14.4 c	12.0 bc
LMix 6	26.8 d	4.6 c	11.5 d	10.8 c
LMix 7	25,6 d	3.6 d	10.9 d	10.4 c

PRODUCTION 2020-2021







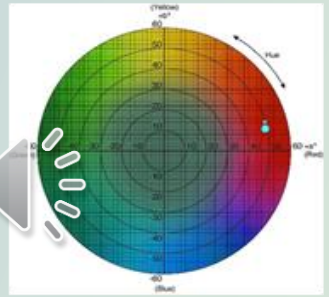
Factor	Max height (cm)	Vegetative sprouts (n)	Lenght primary shoot (cm)	Fully exp. leaves (n.)
Water regime:				
WR1	35	5	19	14
WR2	36	5	21	16
Significance	ns	ns	ns	ns
Substrate:				
LMix 1	44 a	5,8 a	30 a	19,0 a
LMix 2	41 b	5,4 b	23 b	16.0 b
LMix 3	36 c	4,8 c	20 c	15.1 c
LMix 4	40 b	5,4 b	22 b	16.0 b
LMix 5	34 c	4,6 c	17 c	14.6 c
LMix 6	28 d	5,3 d	13 d	13.0 d
LMix 7	27d	4,1 d	13 d	11.0 d
Significance	***	**	***	***

LEAF BLADE COLOUR AND CHROMA INDEX AUGUST 2020

August 2020

Substrate	L brightness	a redness	b yellowness	Chroma index
LMix 1	34.1 a	-6,6 e	11,8 a	13,6 a
LMix 2	34.9 a	-7.1 d	13,1 a	14,8 a
LMix 3	36.1 b	-7.6 c	15,0 b	16,8 b
LMix 4	35,9 b	-7.9 b	15,2 b	17,1 b
LMix 5	36.6 b	-8.0 b	16,2 b	18,1 b
LMix 6	45,3 d	-10.1 a	30,1 d	31,7 d
LMix 7	45.4 c	-9.9 a	27,0 c	28,8 c

Water regime	L brightness	a redness	b yellowness	Chroma Index
WR1	38,3 ns	-8,2 ns	18,7 ns	20,6 ns
WR2	37.8 ns	-8,1 ns	17,9 ns	19,8 ns



CIELab coordinates

October 2020

Substrate	Chroma index
LMix 1	14.1 ab
LMix 2	13.4 a
LMix 3	14.1 ab
LMix 4	14.7 bc
LMix 5	14.3 bc
LMix 6	16.5 d
LMix 7	14.9 c

PLANT DRY WEIGHT (DW) AND TOTAL LEAF AREA (APRIL 2021)

Factor	Stem DW (g)	Leaf DW (g)	Root DW (g)	Total DW (g)	Total leaf area (cm^2)
Substrate					
LMix 1	42.6 a	116.7 ab	134.8 bc	294.1 bc	9.764.2 a
LMix 2	42.8 a	126.0 a	197.7 a	366.4 a	8.632.6 ab
LMix 3	31.6 b	89.3 c	126.7 bcd	247.6 cd	7.282.6 bc
LMix 4	42.3 a	119.4 a	155.5 ab	317.2 ab	8.442.8 ab
LMix 5	31.6 b	93.0 bc	93.3 cd	218.0 de	6.621.3 c
LMix 6	18.4 c	55.4 d	91.7 cd	165.5 e	4.885.4 d
LMix 7	18.2 c	56.6 d	82.5 d	157.3 e	4.357.3 d
Water regime					
WR1	29.6 b	ns	ns	ns	6.677.6 b
WR2	35.3 a	ns	ns	ns	7.604.2 a

Range of lipid peroxidation by measuring malondialdehyde (MDA) concentration and of chlorophylls (a = Chla, b = Chlb, Total = ChlTot) and carotenoids content by spectrophotometer (2020)

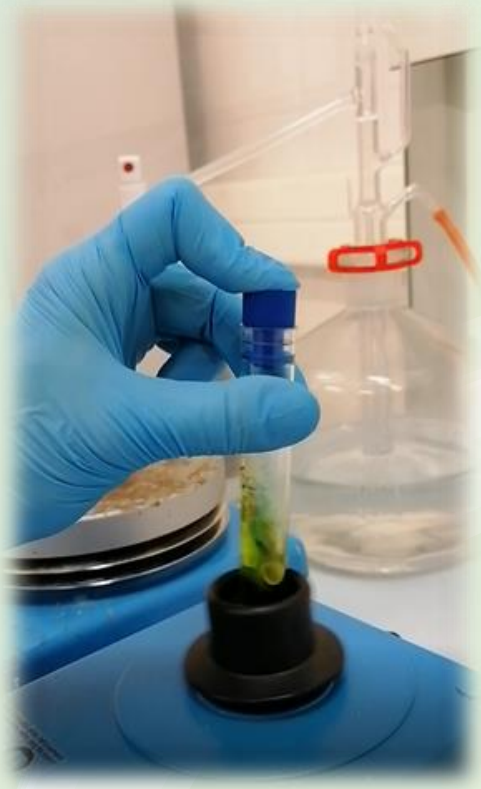
MDA: 0.3 - 0.4 mM/g DW

Chl_a : 1.6 - 2.2 µg/mg FW

Chl_b : 0.8 - 1.0 µg/mg FW

Chl_{Tot} : 2.4 - 3.1 µg/mg FW

Carotenoids: 0.3 - 0.6 µg/mg FW

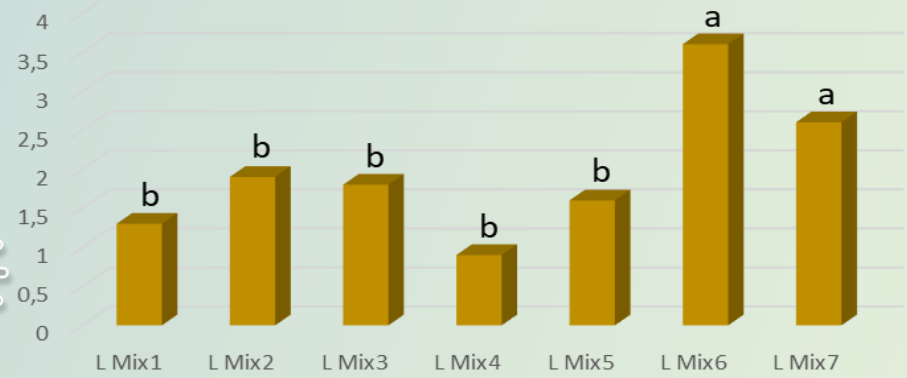


ESTIMATION OF HEAVY METALS IN LAUREL LEAVES (mg kg $^{-1}$ dw)

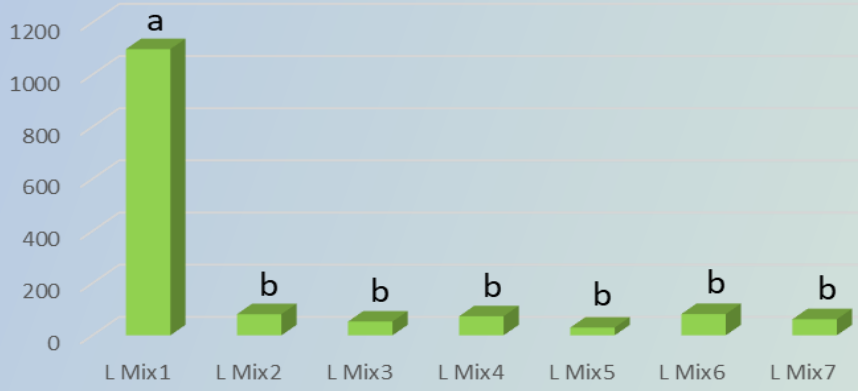
LIFE 17 ENV/IT/000347

Fe

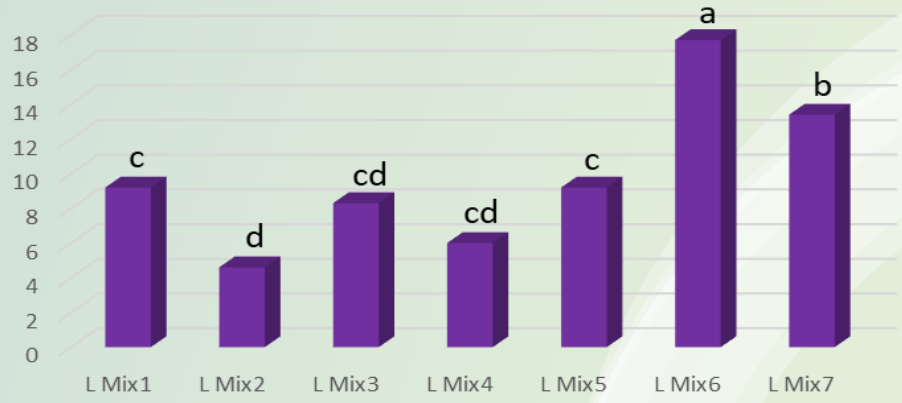
Cu



Mn



Zn

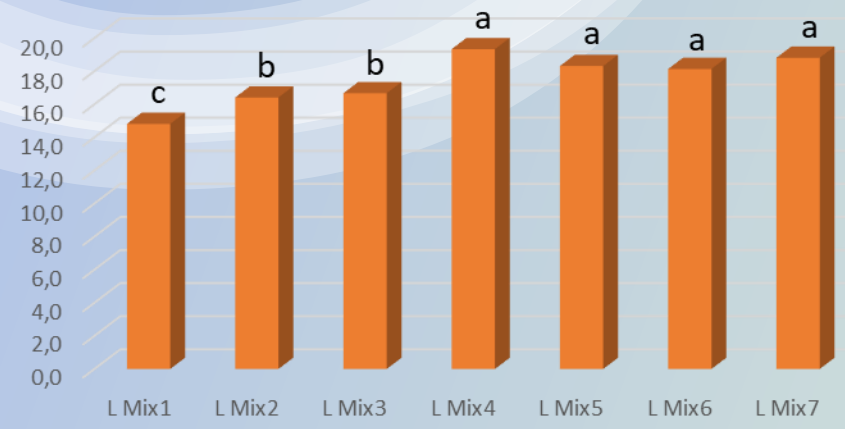


12th International SedNet Conference

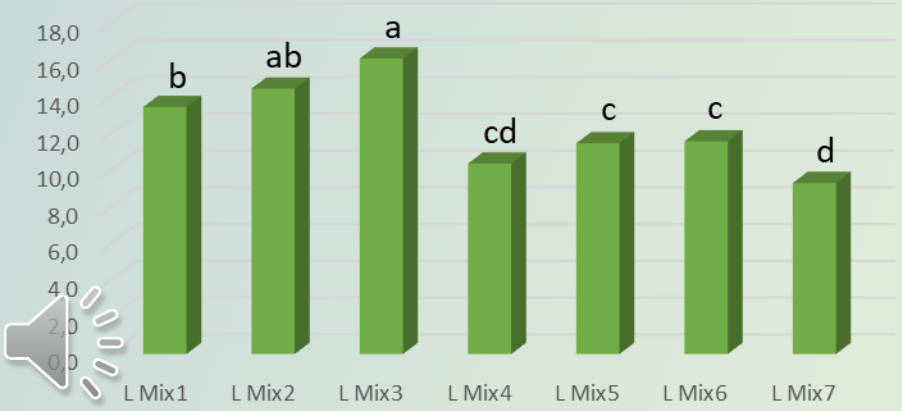
ESTIMATION OF NUTRIENTS IN LAUREL LEAVES (g kg $^{-1}$ dw)

LIFE 17 ENV/IT/000347

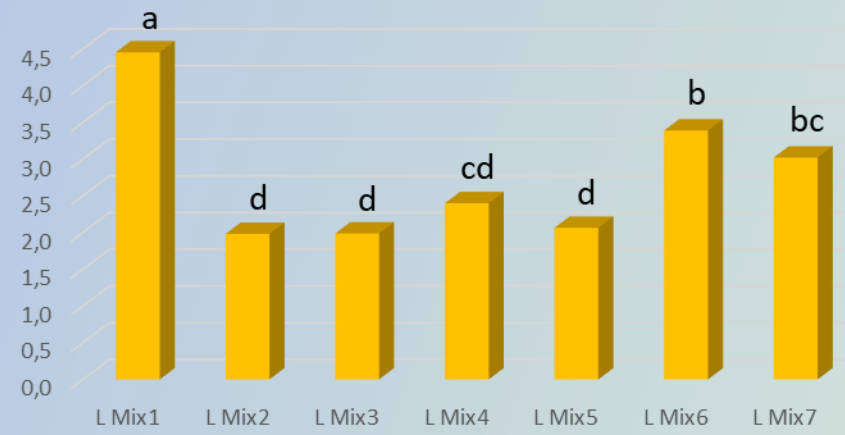
K



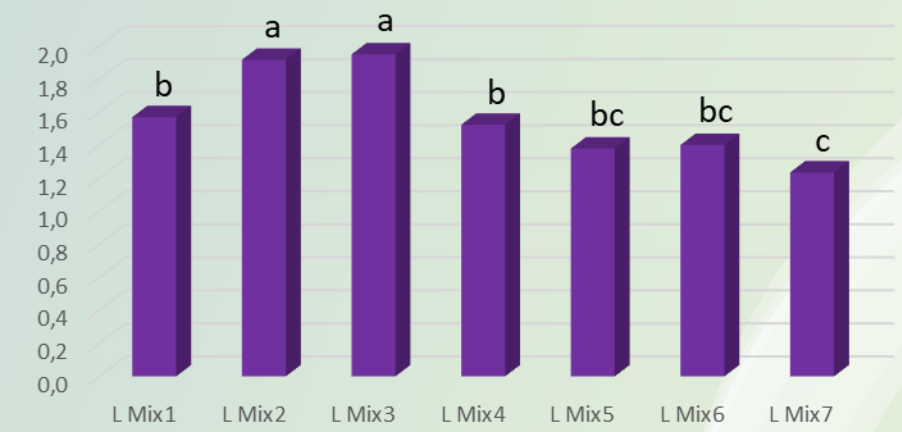
Ca



P



Mg



LIFE 17 ENV/IT/000347

CONCLUSIONS

- All the sediment-based media mixtures showed physicochemical parameters and heavy metal content in line with the Italian regulation for agronomic substrate for mixed growing media (D.L. 75/2010), with the only exception of total organic carbon in substrate LMix 3.
- Finding regarding nutritional elements highlighted the potential suitability of the sediment as an agronomic substrate.
- Results evidenced the possible relocation of phytoremediated sediments for the cultivation of laurel by rooted cuttings in agreement with the principles of circular economy. In fact, laurel plants grew well in all tested substrates, except for those containing 50-75% of wood fiber matrix.
- Reasons for bad testing performance might result from the physical properties of wood fiber substrate.
- Although sediment-based substrates were rich in zinc, this element was found at very low concentrations in plants.

crea
Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria

LIFE 17 ENV/IT/000347

Thank you for your attention!

Advances in the Sustainable Reuse of Sediments in Crop Production: Agronomic, Environmental, and Legal Issues

Guest Editor
Dr. Stefania Nin

Deadline
31 December 2021

Special Issue
Invitation to submit

12th International SedNet Conference