**SUPPLEMENTARY MATERIAL**

**Table S1** Water temperature in the mesocosms system, in the first and second daily cycle, in relation to total, attenuated, and low radiation treatments, and air temperature in the surroundings of the mesocosm.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|   | **time**  | **total**  | **attenuated**  | **low**  | **Air**  |
| DC. 1 |  08:00 a.m. | 8.57 ± 0.01 | 8.50 ± 0.01 | 8.81 ± 0.02 | 8.83 ± 0.16 |
| 13:00 p.m. | 13.22 ± 0.32 | 12.59 ± 0.23 | 12.44 ± 0.23 | 17.53 ± 0.3 |
| 17:00 p.m. | 13.45 ± 0.1 | 12.83 ± 0.06 | 13.15 ± 0.07 | 12.56 ± 0.28 |
| DC. 2 |  08:00 am | 5.64 ± 0.05 | 5.66 ± 0.08 | 6.21 ± 0.04 | 1.90 ± 0.11 |
| 13:00 p.m. | 10.70 ± 0.32 | 10.08 ± 0.23 | 10.29 ± 0.24 | 15.61 ± 1.34 |
| 17:00 p.m. | 10.94 ± 0.13 | 10.31 ± 0.11 | 10.88 ± 0.11 | 8.84 ± 0.31 |

**Table S2** nitrate concentration (µM) in the mesocosms system along to the water column, in wintertime.

|  |  |  |
| --- | --- | --- |
| **water column**  | **Average**  | **SE**  |
| high  | 4.693293 | 0.082575 |
| middle  | 5.133974 | 0.231716 |
| low  | 4.189417 | 0.212336 |

**Table S3** ANOVA results after experimental period testing for the effect of Treatments, time, and Part of thalli of the phenolic compounds, antioxidant activity, chlorophyll *a*, chlorophyll *c1+c2*, fucoxanthin, ratio carbon: nitrogen, carbon, y nitrogen of *Macrocystis pyrifera* in two dayle cycles. Significant differences at α < 0.05 are shown in asterisk.

|  |
| --- |
| ***Macrocystis pyrifera***  |
|  |  | ***DC 1***  | ***DC 2*** |
|   |   | *df* | *MS* | *F* | *P* |  | *df* | *MS* | *F* | *P* |
| ***Phenolics***  | *Treatments (T)* | 2 | 165.02 | 15.99 | **\*** |  | 2 | 142.43 | 6.15 | **\*** |
| ***compounds***  | *time (t)* | 2 | 25.60 | 2.48 | **\*** |  | 2 | 77.55 | 3.35 | **\*** |
|  | *Part of thalli (Pt)* | 2 | 146.14 | 14.16 | **\*** |  | 2 | 59.84 | 2.59 | **\*** |
|  | *T\*t* | 4 | 29.77 | 2.88 | **\*** |  | 4 | 20.07 | 0.87 |  |
|  | *T\*Pt* | 4 | 10.21 | 0.99 |  |  | 4 | 12.69 | 0.55 |  |
|  | *t\*Pt* | 4 | 1.36 | 0.13 |  |  | 4 | 29.66 | 1.28 |  |
|  | *T\*t\*Pt* | 8 | 23.59 | 2.29 | **\*** |  | 8 | 11.62 | 0.50 |  |
|   | *Res* | 81 | 10.32 |   |  |   | 81 | 23.14 |   |  |
| ***AA%*** | *Treatments (T)* | 2 | 781.80 | 5.71 | **\*** |  | 2 | 2212.07 | 9.26 | **\*** |
|  | *time (t)* | 2 | 35.64 | 0.26 |  |  | 2 | 118.1623 | 0.49 |  |
|  | *Part of thalli (Pt)* | 2 | 123.93 | 0.91 |  |  | 2 | 404.9011 | 1.69 |  |
|  | *T\*t* | 4 | 119.95 | 0.88 |  |  | 4 | 60.62978 | 0.25 |  |
|  | *T\*Pt* | 4 | 131.47 | 0.96 |  |  | 4 | 202.3236 | 0.85 |  |
|  | *t\*Pt* | 4 | 64.28 | 0.47 |  |  | 4 | 64.15835 | 0.27 |  |
|  | *T\*t\*Pt* | 8 | 120.13 | 0.88 |  |  | 8 | 30.79988 | 0.13 |  |
|   | *Res* | 81 | 136.80 |   |  |   | 81 | 239.0043 |   |  |
| ***Chla***  | *Treatments (T)* | 2 | 0.04 | 2.15 |  |   | 2 | 0.01 | 0.02 |  |
|  | *time (t)* | 2 | 0.10 | 5.70 | **\*** |  | 2 | 287.54 | 578.26 | **\*** |
|  | *Part of thalli (Pt)* | 2 | 0.20 | 11.19 | **\*** |  | 2 | 572.27 | 1150.85 | **\*** |
|  | *T\*t* | 4 | 0.03 | 1.88 |  |  | 4 | 11.91 | 23.94 | **\*** |
|  | *T\*Pt* | 4 | 0.03 | 1.58 |  |  | 4 | 0.36 | 0.72 |  |
|  | *t\*Pt* | 4 | 0.07 | 4.00 | **\*** |  | 4 | 186.32 | 374.70 | **\*** |
|  | *T\*t\*Pt* | 8 | 0.06 | 3.38 | **\*** |  | 8 | 9.97 | 20.05 | **\*** |
|   | *Res* | 81 | 0.02 |  |  |   | 81 | 0.50 |   |  |
| ***Chlc1+c2*** | *Treatments (T)* | 2 | 0.06 | 0.57 |  |   | 2 | 0.01 | 0.15 |  |
|  | *time (t)* | 2 | 0.19 | 1.66 |  |  | 2 | 0.02 | 0.46 |  |
|  | *Part of thalli (Pt)* | 2 | 0.03 | 0.26 |  |  | 2 | 0.01 | 0.27 |  |
|  | *T\*t* | 4 | 0.09 | 0.76 |  |  | 4 | 0.01 | 0.31 |  |
|  | *T\*Pt* | 4 | 0.01 | 0.08 |  |  | 4 | 0.01 | 0.23 |  |
|  | *t\*Pt* | 4 | 0.02 | 0.22 |  |  | 4 | 0.00 | 0.04 |  |
|  | *T\*t\*Pt* | 8 | 0.04 | 0.32 |  |  | 8 | 0.01 | 0.15 |  |
|   | *Res* | 81 | 0.11 |   |  |   | 81 | 0.04 |   |  |
| ***Fuco***  | *Treatments (T)* | 2 | 0.01 | 0.25 |  |  | 2 | 0.00 | 0.27 |  |
|  | *time (t)* | 2 | 0.03 | 1.11 |  |  | 2 | 0.00 | 0.44 |  |
|  | *Part of thalli (Pt)* | 2 | 0.01 | 0.27 |  |  | 2 | 0.00 | 0.33 |  |
|  | *T\*t* | 4 | 0.00 | 0.07 |  |  | 4 | 0.00 | 0.30 |  |
|  | *T\*Pt* | 4 | 0.00 | 0.16 |  |  | 4 | 0.00 | 0.24 |  |
|  | *t\*Pt* | 4 | 0.00 | 0.12 |  |  | 4 | 0.00 | 0.06 |  |
|  | *T\*t\*Pt* | 8 | 0.00 | 0.08 |  |  | 8 | 0.00 | 0.15 |  |
|   | *Res* | 81 | 0.03 |  |  |  | 81 | 0.01 |   |  |
| ***C:N*** | *Treatments (T)* | 2 | 1.57 | 2.29 |  |   | 2 | 19.40 | 17.59 | **\*** |
|  | *time (t)* | 2 | 0.20 | 0.30 |  |  | 2 | 3.27 | 2.96 | **\*** |
|  | *Part of thalli (Pt)* | 2 | 11.89 | 17.41 | **\*** |  | 2 | 6.43 | 5.83 | **\*** |
|  | *T\*t* | 4 | 0.30 | 0.44 |  |  | 4 | 1.40 | 1.27 |  |
|  | *T\*Pt* | 4 | 0.65 | 0.95 |  |  | 4 | 1.54 | 1.39 |  |
|  | *t\*Pt* | 4 | 2.28 | 3.34 | **\*** |  | 4 | 1.63 | 1.48 |  |
|  | *T\*t\*Pt* | 8 | 1.77 | 2.60 |  |  | 8 | 1.65 | 1.49 |  |
|   | *Res* | 54 | 0.68 |   |  |   | 54 | 1.10 |  |  |
| ***C*** | *Treatments (T)* |   |   |   |  |   | 2 | 570.71 | 7.27 | **\*** |
|  | *time (t)* | 2 | 24.91 | 0.51 |  |  | 2 | 886.63 | 11.30 | **\*** |
|  | *Part of thalli (Pt)* | 2 | 25.10 | 0.52 |  |  | 2 | 351.64 | 4.48 | **\*** |
|  | *T\*t* | 4 | 17.86 | 0.37 |  |  | 4 | 44.96 | 0.57 |  |
|  | *T\*Pt* | 4 | 325.55 | 6.69 | **\*** |  | 4 | 179.69 | 2.29 |  |
|  | *t\*Pt* | 4 | 345.99 | 7.11 | **\*** |  | 4 | 272.55 | 3.47 | **\*** |
|  | *T\*t\*Pt* | 8 | 64.97 | 1.34 | \* |  | 8 | 22.10 | 0.28 | \* |
|   | *Res* | 54 | 48.64 |   |  |   | 54 | 78.49 |   |  |
| ***N*** | *Treatments (T)* | 2 | 8.27 | 3.13 |  |   | 2 | 34.55 | 10.95 | **\*** |
|  | *time (t)* | 2 | 0.54 | 0.20 |  |  | 2 | 0.41 | 0.13 |  |
|  | *Part of thalli (Pt)* | 2 | 42.21 | 15.95 | **\*** |  | 2 | 24.38 | 7.72 | **\*** |
|  | *T\*t* | 4 | 1.15 | 0.43 |  |  | 4 | 3.63 | 1.15 |  |
|  | *T\*Pt* | 4 | 2.55 | 0.96 |  |  | 4 | 4.28 | 1.36 |  |
|  | *t\*Pt* | 4 | 10.93 | 4.13 | **\*** |  | 4 | 8.66 | 2.74 | **\*** |
|  | *T\*t\*Pt* | 8 | 7.19 | 2.72 | **\*** |  | 8 | 3.57 | 1.13 | \* |
|   | *Res* | 54 | 2.65 |   |  |   | 54 | 3.16 |   |  |
| *ETRin situ*  | *Treatments (T)* | 2 | 15160.1 | 25.7 | **\*** |   | 2 | 9310.3 | 63.2 | **\*** |
|  | *time (t)* | 2 | 1804521.8 | 3060.8 | **\*** |  | 2 | 1007803.2 | 6836.8 | **\*** |
|  | *Part of thalli (Pt)* | 2 | 624644.8 | 1059.5 | **\*** |  | 2 | 423648.8 | 2874.0 | **\*** |
|  | *T\*t* | 4 | 10947.5 | 18.6 | **\*** |  | 4 | 5588.5 | 37.9 | **\*** |
|  | *T\*Pt* | 4 | 10188.6 | 17.3 | **\*** |  | 4 | 4056.2 | 27.5 | **\*** |
|  | *t\*Pt* | 4 | 454068.6 | 770.2 | **\*** |  | 4 | 266821.6 | 1810.1 | **\*** |
|  | *T\*t\*Pt* | 8 | 8515.8 | 14.4 | **\*** |  | 8 | 2799.6 | 19.0 | **\*** |
|   | *Res* | 945 | 589.6 |   |   |   | 945 | 147.4 |   |   |
| *Res: Residual*  |  |  |  |  |  |  |  |  |  |

**Table S4** Pearson correlation of the first daily cycle (average of the treatments), respect to the PC, Chla, Chlc1+c2, Fux, AA%, ETR*in situ*, C and N.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | ***PC*** | ***Chla***  | ***Chl c1+c2*** | ***Fuc***  | ***AA%*** | ***ETRin situ*** | ***C*** | ***N*** |
| ***PC*** |   | -0.267 | 0.00575 | 0.0249 | 0.534 | -0.161 | 0.039 | -0.219 |
|   | 0.0161 | 0.959 | 0.825 | 2.8E-07 | 0.15 | 0.729 | 0.05 |
| ***Chla***  |   |   | 0.341 | 0.304 | -0.314 | 0.0503 | 0.0367 | 0.145 |
|  |   |   | 0.00183 | 0.0058 | 0.00433 | 0.656 | 0.745 | 0.196 |
| ***Chl c1+c2*** |   |   |   | 0.998 | -0.197 | -0.00101 | -0.223 | -0.0323 |
|  |   |   |   |   | 0.0774 | 0.993 | 0.0451 | 0.775 |
| ***Fuc*** |   |   |   | -0.171 | -0.0134 | -0.223 | -0.0356 |
|  |   |   |   |   | 0.127 | 0.906 | 0.0456 | 0.752 |
| ***AA%*** |   |   |   |   |   | -0.0968 | 0.0885 | -0.105 |
|  |   |   |   |   |   | 0.39 | 0.432 | 0.35 |
| ***ETRin situ*** |   |   |   |   |   |   | -0.0392 | -0.114 |
|  |   |   |   |   |   |   | 0.728 | 0.309 |
| ***C*** |   |   |   |   |   |   |   | 0.397 |
|  |  |  |  |  |  |  |  | 0.000244 |

**Table S5** Pearson correlation of the second daily cycle (average of the treatments), respect to the PC, Chla, Chl*c1+c2*, Fuc, AA%, ETR*in situ*, C and N.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|   | ***PC*** | ***Chla*** | ***Chlc1+c2*** | ***Fuc*** | ***AA%*** | ***ETRin situ*** | ***C*** | ***N*** |
| ***PC*** |   | 0.0262 | -0.0633 | -0.0829 | 0.579 | -0.198 | -0.0371 | -0.0433 |
|   | 0.816 | 0.575 | 0.462 | 1.47E-08 | 0.0768 | 0.742 | 0.701 |
| ***Chla*** |   |   | 0.454 | 0.426 | -0.168 | -0.0717 | -0.0135 | 0.208 |
|  |   |   | 0.0000205 | 0.0000737 | 0.135 | 0.525 | 0.905 | 0.0627 |
| ***Chlc1+c2*** |   |   |   | 0.958 | -0.118 | 0.00967 | 0.0524 | 0.144 |
|  |   |   |   | 1.29E-41 | 0.295 | 0.932 | 0.642 | 0.2 |
| ***Fuc*** |   |   |   |   | -0.0895 | 0.0178 | 0.0428 | 0.114 |
|  |   |   |   |   | 0.427 | 0.875 | 0.705 | 0.309 |
| ***AA%*** |   |   |   |   |   | -0.0858 | 0.00124 | -0.0795 |
|  |   |   |   |   |   | 0.446 | 0.991 | 0.481 |
| ***ETRin situ*** |   |   |   |   |   |   | 0.153 | -0.0732 |
|  |   |   |   |   |   |   | 0.171 | 0.516 |
| ***C*** |   |   |   |   |   |   |   | 0.288 |
|  |   |   |   |   |   |   |   | 0.00923 |

**Figure S1** Internal carbon content in *Macrocystis pyrifera* fronds in the (A) first daily cycle and (B) second daily cycle experiment under different solar irradiance treatments: total, attenuated, and low radiation at 8:00, 13:00, and 17:00 h. The C was determined in three zones of the alga: canopy, middle, and down (mean ± SE, n = 3). Lower-case letters denote significant differences after the SNK test.



**Figure S2** Internal nitrogen content in *Macrocystis pyrifera* fronds in the (A) first daily cycle and (B) second daily cycle experiment under different solar irradiance treatments: total, attenuated, and low radiation at 8:00, 13:00, and 17:00 h. The N was determined in three zones of the alga: canopy, middle, and down (mean ± SE, n = 3). Lower-case letters denote significant differences after the SNK test.

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