Supplementary Information

An integrated response of *Trichodesmium erythraeum* IMS101 growth and photo-physiology to iron, CO2 and light intensity

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**Supplementary Table 1. The total (FeT) and free (Feʹ) iron concentrations (±S.E.) of the various CO2 and light treatments.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Low CO2** | | **Mid CO2** | | **High CO2** | |
| **Parameters** | **FeT** | **LL** | **HL** | **LL** | **HL** | **LL** | **HL** |
| Light response | 400 | 5507 (952) | 5559 (319) | 6440 (391) | 3694 (445) | 3887 (256) | 9676 (421) |
| Temperature response | 400 | 4938 (136) | 5601 (1) | 4513 (385) | 6200 (448) | 3950 (248) | 8909 (135) |
| Iron response | 400 | 288 (24) | 550 (16) | 393 (14) | 562 (19) | 355 (13) | 853 (5) |
|  | 200 | 444 (24) | 489 (22) | 347 (21) | 649 (34) | 350 (26) | 1037 (3) |
|  | 100 | 435 (60) | 563 (45) | 335 (8) | 596 (22) | 205 (4) | 478 (12) |
|  | 40 | 494 (12) | 539 (26) | 357 (6) | 597 (21) | 102 (4) | 289 (9) |
|  | 4 |  | 239 (16) |  | 66 (1) |  | 23 (1) |

Light and temperature response cultures used a 2 µM EDTA concentration, as reported in [Boatman et al. (2017](#_ENREF_2)). The iron response cultures used a 20 µM EDTA concentration.

**Supplementary Table 2. The variance of separated-CO2 (e.g. Mid) and combined-CO2 (e.g. Low + Mid) growth rate-Feʹ curves; where µm and Km were modelled using a Michaelis-Menten equation (**[**Michaelis & Menten, 1913**](#_ENREF_5)**).**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **µm** | **S.E.** | ***t*-value** | ***p*** | **Km** | **S.E.** | ***t*-value** | ***p*** | **RSS** | **df** |
| Low Light |  |  |  |  |  |  |  |  |  |  |
| LCO2 | 0.104 | 0.0053 | 19.56 | < 0.0001 | 306.98 | 56.21 | 5.46 | 0.0055 | 0.0002 | 4 |
| MCO2 | 0.136 | 0.0062 | 21.85 | < 0.0001 | 116.36 | 29.31 | 3.97 | 0.0165 | 0.0002 | 4 |
| HCO2 | 0.134 | 0.0120 | 11.23 | 0.0004 | 123.97 | 47.51 | 2.61 | 0.0594 | 0.0010 | 4 |
| LCO2 + MCO2 | 0.115 | 0.0135 | 8.55 | < 0.0001 | 156.19 | 87.14 | 1.79 | 0.1033 | 0.0056 | 10 |
| LCO2 + HCO2 | 0.112 | 0.0133 | 8.44 | < 0.0001 | 144.67 | 78.38 | 1.85 | 0.0947 | 0.0058 | 10 |
| MCO2 + HCO2 | 0.134 | 0.0006 | 21.70 | < 0.0001 | 117.49 | 26.45 | 4.44 | 0.0013 | 0.0013 | 10 |
| LCO2 + MCO2 + HCO2 | 0.119 | 0.0100 | 11.90 | < 0.0001 | 131.00 | 53.89 | 2.43 | 0.0272 | 0.0080 | 16 |
| High Light |  |  |  |  |  |  |  |  |  |  |
| LCO2 | 0.193 | 0.0211 | 9.16 | 0.0003 | 236.14 | 104.16 | 2.27 | 0.0727 | 0.0033 | 5 |
| MCO2 | 0.337 | 0.0245 | 13.74 | < 0.0001 | 205.80 | 71.16 | 2.89 | 0.0341 | 0.0045 | 5 |
| HCO2 | 0.367 | 0.0161 | 22.71 | < 0.0001 | 201.19 | 45.86 | 4.37 | 0.0071 | 0.0025 | 5 |
| LCO2 + MCO2 | 0.270 | 0.0395 | 6.83 | < 0.0001 | 241.81 | 148.01 | 1.63 | 0.1283 | 0.0538 | 12 |
| LCO2 + HCO2 | 0.295 | 0.0434 | 6.78 | < 0.0001 | 290.68 | 171.03 | 1.70 | 0.1150 | 0.0712 | 12 |
| MCO2 + HCO2 | 0.354 | 0.0148 | 23.84 | 0.0001 | 209.68 | 42.96 | 4.88 | 0.0004 | 0.0090 | 12 |
| LCO2 + MCO2 + HCO2 | 0.309 | 0.0314 | 9.82 | < 0.0001 | 256.72 | 110.58 | 2.32 | 0.0315 | 0.0865 | 19 |

An *F*-statistic was calculated as the (RSS/df) of a separate fit, divided by the (RSS/df) of the difference between the separate and combined fit; this was then compared against an *F*-value from an *F*-distribution table using a .05 alpha level.

**Supplementary Table 3. The variance of separated-CO2 (e.g. Mid) and combined-CO2 (e.g. Low + Mid) growth rate-Feʹ curves, modelled using a Michaelis-Menten equation (**[**Michaelis & Menten, 1913**](#_ENREF_5)**); where each curve was normalised to the modelled maximum growth rate (µm) for that CO2 and light treatment.**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **µm** | **S.E.** | ***t*-value** | ***p*** | **Km** | **S.E.** | ***t*-value** | ***p*** | **RSS** | **df** |
| Low Light |  |  |  |  |  |  |  |  |  |  |
| LCO2 | 1.0 | 0.0464 | 21.55 | < 0.0001 | 309.95 | 51.17 | 6.06 | 0.0038 | 0.0114 | 4 |
| MCO2 | 1.0 | 0.0523 | 19.13 | < 0.0001 | 104.16 | 32.26 | 3.23 | 0.0320 | 0.0176 | 4 |
| HCO2 | 1.0 | 0.0876 | 11.41 | 0.0003 | 125.21 | 47.28 | 2.65 | 0.0571 | 0.0519 | 4 |
| LCO2 + MCO2 | 1.0 | 0.0676 | 14.78 | < 0.0001 | 182.71 | 54.06 | 3.38 | 0.0070 | 0.1376 | 10 |
| LCO2 + HCO2 | 1.0 | 0.0712 | 14.05 | < 0.0001 | 188.75 | 54.84 | 3.44 | 0.0063 | 0.1537 | 10 |
| MCO2 + HCO2 | 1.0 | 0.0459 | 21.80 | < 0.0001 | 115.78 | 26.21 | 4.42 | 0.0013 | 0.0720 | 10 |
| LCO2 + MCO2 + HCO2 | 1.0 | 0.0525 | 19.03 | < 0.0001 | 157.06 | 36.90 | 4.26 | 0.0006 | 0.2098 | 16 |
| High Light |  |  |  |  |  |  |  |  |  |  |
| LCO2 | 1.0 | 0.1104 | 9.06 | 0.0003 | 232.91 | 103.87 | 2.24 | 0.0750 | 0.0907 | 5 |
| MCO2 | 1.0 | 0.0765 | 13.07 | < 0.0001 | 206.41 | 75.27 | 2.74 | 0.0407 | 0.0441 | 5 |
| HCO2 | 1.0 | 0.0445 | 22.46 | < 0.0001 | 201.24 | 46.24 | 4.34 | 0.0075 | 0.0192 | 5 |
| LCO2 + MCO2 | 1.0 | 0.0617 | 16.21 | < 0.0001 | 213.24 | 58.36 | 3.65 | 0.0033 | 0.1378 | 12 |
| LCO2 + HCO2 | 1.0 | 0.0523 | 19.11 | < 0.0001 | 219.54 | 51.79 | 4.24 | 0.0011 | 0.1119 | 12 |
| MCO2 + HCO2 | 1.0 | 0.0385 | 25.97 | < 0.0001 | 195.68 | 38.11 | 5.13 | 0.0002 | 0.0625 | 12 |
| LCO2 + MCO2 + HCO2 | 1.0 | 0.0409 | 24.44 | < 0.0001 | 210.06 | 39.92 | 5.26 | < 0.0001 | 0.1574 | 19 |

An *F*-statistic was calculated as the (RSS/df) of a separate fit, divided by the (RSS/df) of the difference between the separate and combined fit; this was then compared against an *F*-value from an *F*-distribution table using a .05 alpha level.

**Supplementary Table 4. The variance of separated-CO2 (e.g. Mid) and combined-CO2 (e.g. Low + Mid) growth rate-Feʹ curves, modelled using a Michaelis-Menten equation (**[**Michaelis & Menten, 1913**](#_ENREF_5)**); where each curve was normalised to the modelled half saturation parameter (Km) for that CO2 and light treatment.**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **µm** | **S.E.** | ***t*-value** | ***p*** | **Km** | **S.E.** | ***t*-value** | ***p*** | **RSS** | **df** |
| Low Light |  |  |  |  |  |  |  |  |  |  |
| LCO2 | 0.104 | 0.0048 | 21.66 | < 0.0001 | 1.0 | 0.1642 | 6.09 | 0.0037 | 0.0001 | 4 |
| MCO2 | 0.132 | 0.0069 | 19.12 | < 0.0001 | 1.0 | 0.3101 | 3.23 | 0.0321 | 0.0003 | 4 |
| HCO2 | 0.134 | 0.0117 | 11.45 | 0.0003 | 1.0 | 0.3766 | 2.66 | 0.0567 | 0.0009 | 4 |
| LCO2 + MCO2 | 0.121 | 0.0074 | 16.23 | < 0.0001 | 1.0 | 0.2770 | 3.61 | 0.0048 | 0.0018 | 10 |
| LCO2 + HCO2 | 0.121 | 0.0091 | 13.17 | < 0.0001 | 1.0 | 0.2967 | 3.37 | 0.0071 | 0.0025 | 10 |
| MCO2 + HCO2 | 0.133 | 0.0060 | 22.23 | < 0.0001 | 1.0 | 0.2253 | 4.44 | 0.0013 | 0.0012 | 10 |
| LCO2 + MCO2 + HCO2 | 0.125 | 0.0063 | 19.71 | < 0.0001 | 1.0 | 0.2249 | 4.45 | 0.0004 | 0.0032 | 16 |
| High Light |  |  |  |  |  |  |  |  |  |  |
| LCO2 | 0.193 | 0.0213 | 9.077 | 0.0003 | 1.0 | 0.4459 | 2.24 | 0.0750 | 0.0034 | 5 |
| MCO2 | 0.337 | 0.0247 | 13.647 | < 0.0001 | 1.0 | 0.3496 | 2.86 | 0.0354 | 0.0046 | 5 |
| HCO2 | 0.367 | 0.0163 | 22.456 | < 0.0001 | 1.0 | 0.2308 | 4.34 | 0.0075 | 0.0026 | 5 |
| LCO2 + MCO2 | 0.266 | 0.0371 | 7.172 | < 0.0001 | 1.0 | 0.6092 | 1.64 | 0.1266 | 0.0500 | 12 |
| LCO2 + HCO2 | 0.281 | 0.0403 | 6.973 | < 0.0001 | 1.0 | 0.6478 | 1.54 | 0.1486 | 0.0674 | 12 |
| MCO2 + HCO2 | 0.352 | 0.0148 | 23.813 | < 0.0001 | 1.0 | 0.2084 | 4.80 | 0.0004 | 0.0090 | 12 |
| LCO2 + MCO2 + HCO2 | 0.300 | 0.0292 | 10.280 | < 0.0001 | 1.0 | 0.4473 | 2.24 | 0.0376 | 0.0806 | 19 |

An *F*-statistic was calculated as the (RSS/df) of a separate fit, divided by the (RSS/df) of the difference between the separate and combined fit; this was then compared against an *F*-value from an *F*-distribution table using a .05 alpha level.

**Supplementary Table 5. The variance of separated-CO2 (e.g. Mid) and combined-CO2 (e.g. Low + Mid) growth rate-Feʹ curves, modelled using a P-E equation (**[**Michaelis & Menten, 1913**](#_ENREF_5)**;** [**Platt & Gallegos, 1980**](#_ENREF_7)**); where each curve was normalised to the modelled maximum growth rate (µm) for that CO2 and light treatment.**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **µm** | **S.E.** | ***t*-value** | ***p*** | **α** | **S.E.** | ***t*-value** | ***p*** | **RSS** | **df** |
| Low Light |  |  |  |  |  |  |  |  |  |  |
| LCO2 | 1.0 | 0.0049 | 20.33 | < 0.0001 | 0.0022 | 0.0002 | 9.85 | 0.0006 | 0.0195 | 4 |
| MCO2 | 1.0 | 0.0042 | 24.02 | < 0.0001 | 0.0044 | 0.0004 | 9.74 | 0.0006 | 0.0139 | 4 |
| HCO2 | 1.0 | 0.0050 | 20.13 | < 0.0001 | 0.0051 | 0.0007 | 7.80 | 0.0015 | 0.0214 | 4 |
| LCO2 + MCO2 | 1.0 | 0.0056 | 17.66 | < 0.0001 | 0.0031 | 0.0004 | 8.04 | < 0.0001 | 0.1271 | 10 |
| LCO2 + HCO2 | 1.0 | 0.0069 | 14.04 | < 0.0001 | 0.0035 | 0.0006 | 5.83 | 0.0002 | 0.1968 | 10 |
| MCO2 + HCO2 | 1.0 | 0.0033 | 30.52 | < 0.0001 | 0.0046 | 0.0004 | 11.64 | < 0.0001 | 0.0444 | 10 |
| LCO2 + MCO2 + HCO2 | 1.0 | 0.0048 | 20.51 | < 0.0001 | 0.0037 | 0.0004 | 8.44 | < 0.0001 | 0.2245 | 16 |
| High Light |  |  |  |  |  |  |  |  |  |  |
| LCO2 | 1.0 | 0.0783 | 12.77 | < 0.0001 | 0.0027 | 0.0005 | 5.87 | 0.0020 | 0.0634 | 5 |
| MCO2 | 1.0 | 0.0642 | 15.57 | < 0.0001 | 0.0028 | 0.0005 | 5.82 | 0.0021 | 0.0423 | 5 |
| HCO2 | 1.0 | 0.0402 | 24.93 | < 0.0001 | 0.0028 | 0.0004 | 7.92 | 0.0005 | 0.0206 | 5 |
| LCO2 + MCO2 | 1.0 | 0.0460 | 21.73 | < 0.0001 | 0.0027 | 0.0003 | 9.07 | < 0.0001 | 0.1057 | 12 |
| LCO2 + HCO2 | 1.0 | 0.0389 | 25.73 | < 0.0001 | 0.0028 | 0.0003 | 10.04 | < 0.0001 | 0.0842 | 12 |
| MCO2 + HCO2 | 1.0 | 0.0338 | 29.58 | < 0.0001 | 0.0028 | 0.0003 | 10.23 | < 0.0001 | 0.0631 | 12 |
| LCO2 + MCO2 + HCO2 | 1.0 | 0.0315 | 31.76 | < 0.0001 | 0.0028 | 0.0002 | 12.22 | < 0.0001 | 0.1265 | 19 |

An *F*-statistic was calculated as the (RSS/df) of a separate fit, divided by the (RSS/df) of the difference between the separate and combined fit; this was then compared against an *F*-value from an *F*-distribution table using a .05 alpha level.

**Supplementary Table 6. The variance of separated-CO2 (e.g. Mid) and combined-CO2 (e.g. Low + Mid) maximum relative PSII electron transport (rPm)-Feʹ curves; where rPm and KmrPm were modelled using a Michaelis-Menten equation (**[**Michaelis & Menten, 1913**](#_ENREF_5)**).**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **rPm** | **S.E.** | ***t*-value** | ***p*** | **KmrPm** | **S.E.** | ***t*-value** | ***p*** | **RSS** | **df** |
| Low Light |  |  |  |  |  |  |  |  |  |  |
| LCO2 | 152.37 | 11.20 | 13.61 | 0.0009 | 21.88 | 35.01 | 0.62 | 0.5763 | 361.4 | 3 |
| MCO2 | 153.72 | 26.42 | 5.82 | 0.0101 | 21.73 | 74.75 | 0.29 | 0.7902 | 1860.9 | 3 |
| HCO2 | 162.00 | 14.64 | 11.07 | 0.0016 | 35.65 | 24.92 | 1.43 | 0.2480 | 916.4 | 3 |
| LCO2 + MCO2 | 152.91 | 12.22 | 12.51 | < 0.0001 | 21.36 | 36.27 | 0.59 | 0.5721 | 2226.7 | 8 |
| LCO2 + HCO2 | 157.26 | 7.35 | 21.38 | < 0.0001 | 31.03 | 15.64 | 1.98 | 0.0825 | 1348.3 | 8 |
| MCO2 + HCO2 | 158.47 | 11.03 | 14.37 | < 0.0001 | 31.85 | 22.83 | 140 | 0.2004 | 2821.0 | 8 |
| LCO2 + MCO2 + HCO2 | 156.59 | 7.54 | 20.76 | < 0.0001 | 29.73 | 17.33 | 1.72 | 0.1100 | 3219.1 | 13 |
| High Light |  |  |  |  |  |  |  |  |  |  |
| LCO2 | 233.41 | 27.04 | 8.63 | 0.0010 | 151.39 | 79.82 | 1.90 | 0.1307 | 2679.0 | 4 |
| MCO2 | 222.82 | 6.26 | 35.58 | <0 .0001 | 77.08 | 14.24 | 5.41 | 0.0056 | 317.3 | 4 |
| HCO2 | 211.81 | 19.42 | 10.90 | 0.0004 | 17.16 | 13.92 | 1.23 | 0.2851 | 6101.8 | 4 |
| LCO2 + MCO2 | 225.97 | 12.27 | 18.42 | < 0.0001 | 107.84 | 33.60 | 3.21 | 0.0093 | 3836.2 | 10 |
| LCO2 + HCO2 | 202.29 | 13.71 | 14.75 | < 0.0001 | 23.34 | 17.56 | 1.33 | 0.2133 | 13597.5 | 10 |
| MCO2 + HCO2 | 214.92 | 12.12 | 17.74 | < 0.0001 | 38.56 | 18.03 | 2.14 | 0.0582 | 9070.5 | 10 |
| LCO2 + MCO2 + HCO2 | 217.56 | 12.27 | 17.73 | < 0.0001 | 64.32 | 27.41 | 2.35 | 0.0322 | 14647.6 | 16 |

An *F*-statistic was calculated as the (RSS/df) of a separate fit, divided by the (RSS/df) of the difference between the separate and combined fit; this was then compared against an *F*-value from an *F*-distribution table using a .05 alpha level.

**Supplementary Table 7. The variance of separated-CO2 (e.g. Mid) and combined-CO2 (e.g. Low + Mid) maximum relative PSII electron transport-Feʹ curves, modelled using a Michaelis-Menten equation (**[**Michaelis & Menten, 1913**](#_ENREF_5)**); where each curve was normalised to the modelled maximum relative PSII electron transport (rPm) for that CO2 and light treatment.**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **rPm** | **S.E.** | ***t*-value** | ***p*** | **KmrPm** | **S.E.** | ***t*-value** | ***p*** | **RSS** | **df** |
| Low Light |  |  |  |  |  |  |  |  |  |  |
| LCO2 | 1.0 | 0.07 | 13.61 | 0.0009 | 21.88 | 35.01 | 0.62 | 0.5763 | 0.0156 | 3 |
| MCO2 | 1.0 | 0.17 | 5.82 | 0.0101 | 21.73 | 74.75 | 0.29 | 0.7902 | 0.0788 | 3 |
| HCO2 | 1.0 | 0.09 | 11.07 | 0.0016 | 35.65 | 24.92 | 1.43 | 0.2480 | 0.0349 | 3 |
| LCO2 + MCO2 | 1.0 | 0.08 | 12.57 | < 0.0001 | 21.78 | 36.15 | 0.60 | 0.5635 | 0.0943 | 8 |
| LCO2 + HCO2 | 1.0 | 0.05 | 21.65 | < 0.0001 | 35.80 | 16.00 | 2.24 | 0.0556 | 0.0526 | 8 |
| MCO2 + HCO2 | 1.0 | 0.07 | 14.13 | < 0.0001 | 35.22 | 23.78 | 1.48 | 0.1769 | 0.1163 | 8 |
| LCO2 + MCO2 + HCO2 | 1.0 | 0.05 | 20.56 | < 0.0001 | 34.29 | 18.03 | 1.90 | 0.0795 | 0.1329 | 13 |
| High Light |  |  |  |  |  |  |  |  |  |  |
| LCO2 | 1.0 | 0.16 | 8.63 | 0.0010 | 151.39 | 79.82 | 1.90 | 0.1307 | 0.0492 | 4 |
| MCO2 | 1.0 | 0.03 | 35.58 | < 0.0001 | 77.08 | 14.24 | 5.41 | 0.0056 | 0.0064 | 4 |
| HCO2 | 1.0 | 0.09 | 10.90 | 0.0004 | 17.92 | 13.92 | 1.23 | 0.2851 | 0.1360 | 4 |
| LCO2 + MCO2 | 1.0 | 0.06 | 17.02 | < 0.0001 | 109.05 | 36.53 | 2.99 | 0.0137 | 0.0859 | 10 |
| LCO2 + HCO2 | 1.0 | 0.07 | 13.46 | < 0.0001 | 19.48 | 16.87 | 1.16 | 0.2749 | 0.3477 | 10 |
| MCO2 + HCO2 | 1.0 | 0.06 | 16.67 | < 0.0001 | 37.84 | 18.93 | 2.00 | 0.0735 | 0.2191 | 10 |
| LCO2 + MCO2 + HCO2 | 1.0 | 0.06 | 15.77 | < 0.0001 | 64.47 | 30.87 | 2.09 | 0.0531 | 0.3743 | 16 |

An *F*-statistic was calculated as the (RSS/df) of a separate fit, divided by the (RSS/df) of the difference between the separate and combined fit; this was then compared against an *F*-value from an *F*-distribution table using a .05 alpha level.

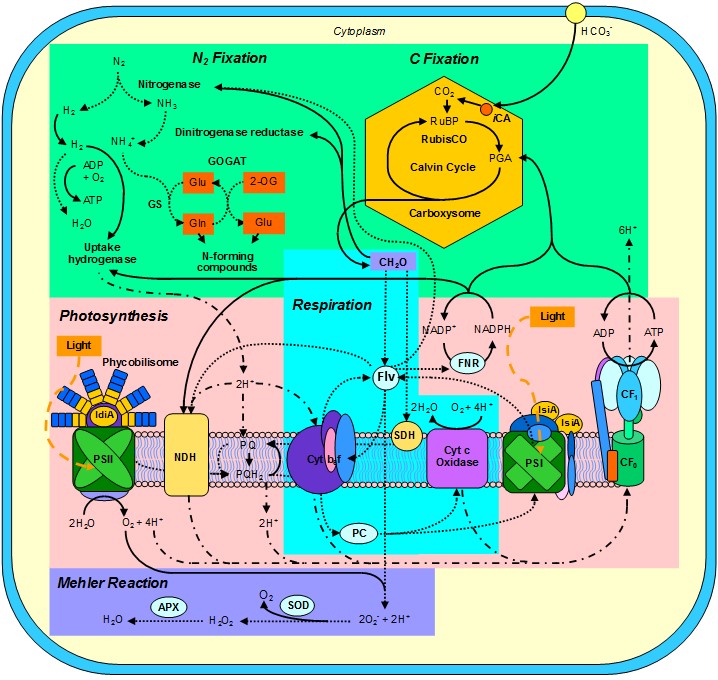
**Supplementary Table 8. Mean dissolved inorganic N concentrations (µM) measured from Fe-replete (2 µM EDTA), optimal growth temperature cultures reported in** [**Boatman et al. (2017**](#_ENREF_2)**).**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Low CO2** | | **Mid CO2** | | **High CO2** | |
| **Parameters** | **Units** | **LL** | **HL** | **LL** | **HL** | **LL** | **HL** |
| Temperature response |  |  |  |  |  |  |  |
| NH4+ | µM | 1.66 (0.52) | 1.00 (0.31) | 0.92 (0.20) | 0.90 (0.20) | 1.04 (0.22) | 1.13 (0.24) |
| NO3- | µM | 0.11 (0.01) | 0.21 (0.06) | 0.19 (0.04) | 0.21 (0.05) | 0.14 (0.03) | 0.20 (0.04) |
| Light response |  |  |  |  |  |  |  |
| NH4+ | µM | 0.90 (0.07) | 1.04 (0.30) | 0.69 (0.21) | 0.94 (0.28) | 0.85 (0.25) | 0.94 (0.11) |
| NO3- | µM | 0.09 (0.01) | 0.15 (0.04) | 0.09 (0.03) | 0.17 (0.05) | 0.13 (0.04) | 0.18 (0.02) |

*T. erythraeum* IMS101 cultures were fully acclimated to three CO2 concentrations (Low CO2 = 180 µatm, Mid CO2 = 380 µatm and High CO2 = 720 µatm), two light intensities (LL = 40 µmol photons m-2 s-1; HL = 400 µmol photons m-2 s-1), under Fe replete conditions at optimal temperature (26.2 °C). Nitrate concentrations were measured spectrophotometrically as described by [Collos *et al.* (1999](#_ENREF_4)), and were always less than the detection limit (1 µM) of the method.

**Supplementary Figure 1. The mean (± S.E.) non-baseline (*Fb*) corrected photochemical efficiency of PSII in the dark-acclimated state (*Fv*/*Fm*) (A,B) and absorption cross section of PSII photochemistry (σLHII = σPII / *Fv*/*Fm*) for *T. erythraeum* IMS101.** Left-hand panels (A,C) are low light treatments while right-hand panels (B,D) are high light treatments. Cultures were acclimated to three targeted CO2 concentrations (Low = 180 µatm (green circles), Mid = 380 µatm (blue circles) and High = 720 µatm (orange circles)), two light intensities (LL = 40 µmol photons m-2 s-1, HL = 400 µmol photons m-2 s-1), across a range of Feʹ concentrations (~ 20 - 9600 pM) and at optimal temperature (26 °C).

F:\Re-submission\Fig S2.TIF**Supplementary Figure 2.** **The iron-limited mean (± S.E.) maximum relative PSII electron transport rate (rPm) (A), photochemical efficiency of PSII in the dark-acclimated state (*Fv*/*Fm*) (B), initial slope of the rP-Feʹ curve (α) (C), slope of photoinhibition (β) (D), light-saturated parameter (Ek) (E) and light intensity at which rP was maximal (Eopt) (F) for *T. erythraeum* IMS101.** Cultures were acclimated to three targeted CO2 concentrations (Low = 180 µatm (green circles), Mid = 380 µatm (blue circles) and High = 720 µatm (orange circles)), two light intensities (LL = 40 µmol photons m-2 s-1 (open circles), HL = 400 µmol photons m-2 s-1 (closed circles)), across a range of Feʹ concentrations (~ 20 - 1010 pM), at optimal temperature (26 °C).

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**Supplementary Figure 3.** **A metabolic schematic model illustrating the effects of iron limitation on the electron transport among primary components of photosynthesis (pink box), nitrogen and carbon fixation (green box), respiration (blue box) and the Mehler reaction (purple box) in *T. erythraeum* IMS101, as adapted from** [**Shi *et al.* (2007**](#_ENREF_8)**).** Iron deficiency triggers the synthesis of IsiA and IdiA proteins. IsiA forms an additional antenna around PSI ([Bibby *et al.*, 2001](#_ENREF_1); [Boekema *et al.*, 2001](#_ENREF_3)), while IdiA has an implicit role in protecting the acceptor side of PSII to compensate for phycobilisome degradation ([Michel & Pistorius, 2004](#_ENREF_6)). The dashed lines indicate electron flow, and the dash-dot lines indicate proton flow. Note, the over-reduction hypothesis yields an increased production of reactive oxygen species (ROS), potentially compromising the oxygen consumption by the Mehler reaction as several ROS-detoxifying enzymes such as superoxide dismutase (SOD) and ascorbate peroxidase (APX) require Fe as a cofactor. The reduction of N2 to NH4+ requires 2 ATP molecules per electron transfer from dintrogenase reductase to dinitrogenase; therefore, the reduction of N2 to NH4+ requires 16 ATP molecules. Photosystem I transports electrons to flavodoxin (Flv), which can be directed to the following: nitrogenase for N2 fixation; Fd oxidoreductase (FNR) for the production of NADPH; Mehler activity for superoxide dismutase (SOD); Cyt*b6f* complex for cyclic electron transport around PSI.

**Supplementary Figure 4.** **The mean (± S.E.) relative PSII electron transport rate (rP) and photochemical efficiency of PSII (*Fq*ʹ/*Fm*ʹ) measured during fluorescence light curves (*n* = 3).** *T. erythraeum* was acclimated to low light (40 µmol photons m-2 s-1) (A-F) and high light (400 µmol photons m-2 s-1) (G-L) conditions, three targeted CO2 concentrations (Low = 180 µatm (Left panels), Mid = 380 µatm (Middle panels) and High = 720 µatm (Right panels)), at optimal temperature (26 °C) and across a range of Feʹ concentrations (~ 102 - 9709 pM).

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