The 2022 International Symposium on Ecohydraulics

October 10-13, 2022
Nanjing, China

ISE 2022

Interaction of flow turbulence and nitrogen nutrients on the growth of *Scenedesmus quadricauda*

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Objectives

Research Hypothesis

(i) TN concentration and turbulence intensity have an interaction t on algal growth.

(ii) The maximum biomass of algae is related to the mixing and homogenization effect of nutrients in the overall environment.

The improved Logist model could reflect quantitative mathematical relationship between the effects and algal population dynamics.

Methods

Custome-made turbulence generation devices with glass annular flumes and agitating electric grids were constructed to generate turbulence flow. An improved logistic model was further fitted to explore the interaction between turbulence and nutrients on the growth of *Scenedesmus quadricauda*.

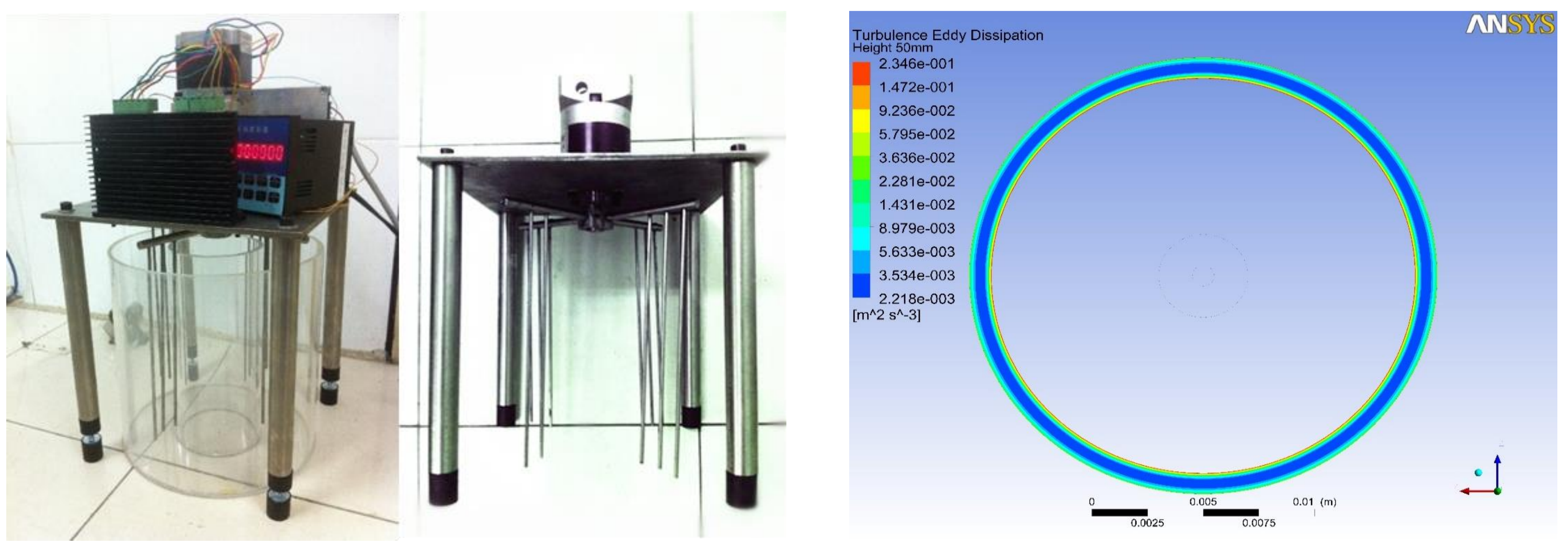

Fig.1 Experimental setup and Stirring grid (Left) Turbulent intensity distribution ε (m^2/s^3)in the setup (Right)

Table 1. Rotating speeds and energy dissipation rates (ε).

Frequency（Hz）	Rotating speed of grids（rad/s）	Volume average flow velocity（m/s）	Intermediate layer area average flow velocity（m/s）	Energy dissipation rates（m^2/s^3）
500	1.57	0.009	0.023 ±0.001	$1.7\times10^{-4}\pm1\times10^{-5}$
1000	3.14	0.020	0.043 ±0.001	$3.25\times10^{-3}\pm1\times10^{-4}$
1500	4.71	0.031	0.063 ±0.002	$8.93\times10^{-3}\pm3.2\times10^{-4}$
2000	6.28	0.036	0.071 ±0.002	$1.695\times10^{-2}\pm2\times10^{-3}$
2500	7.85	0.044	0.084 ±0.003	$2.339\times10^{-2}\pm2.6\times10^{-3}$

Results

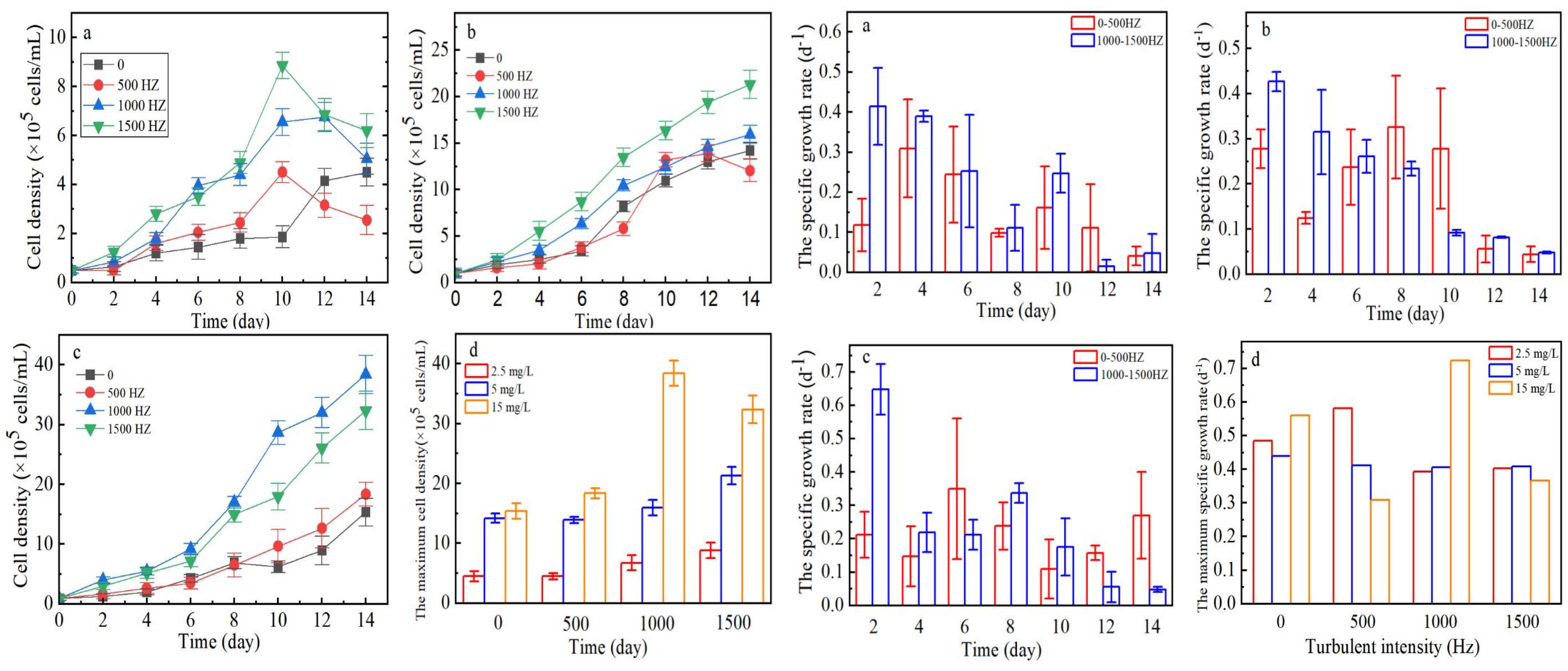

Fig.2 Algae cell density (Left). Specific growth rate (Right). (2.5 mg/L, 5 mg/L, 15 mg/L; a, b & c. The maximum cell density / specific growth rate under different turbulent intensities (d).

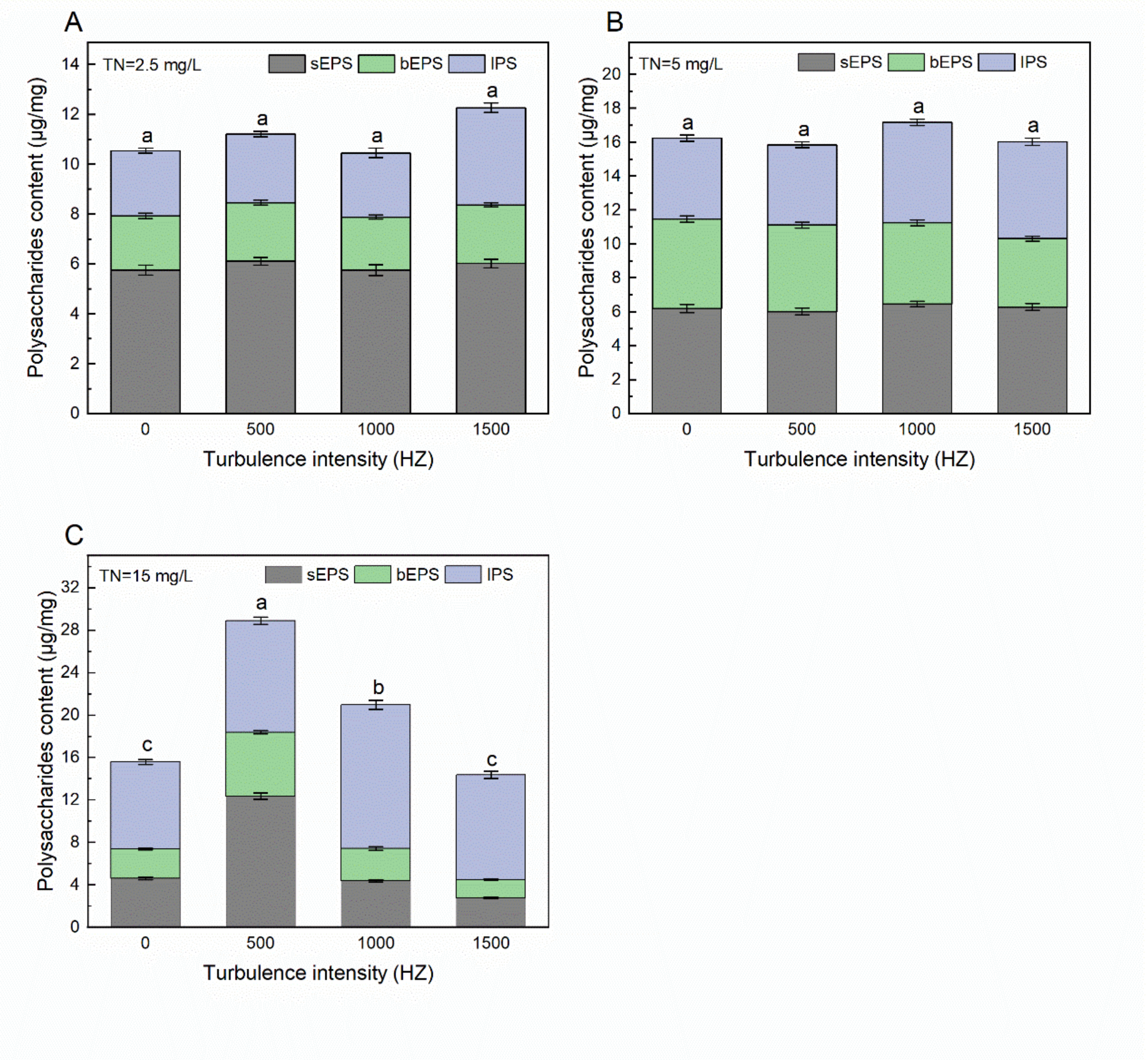

Fig.3 The total chlorophyll a concentration (2.5 mg/L, 5 mg/L, 15 mg/L; a, b, c). The maximum chlorophyll a concentration (d). High TN concentration could weaken the inhibitory effect of high turbulence on chlorophyll-a.

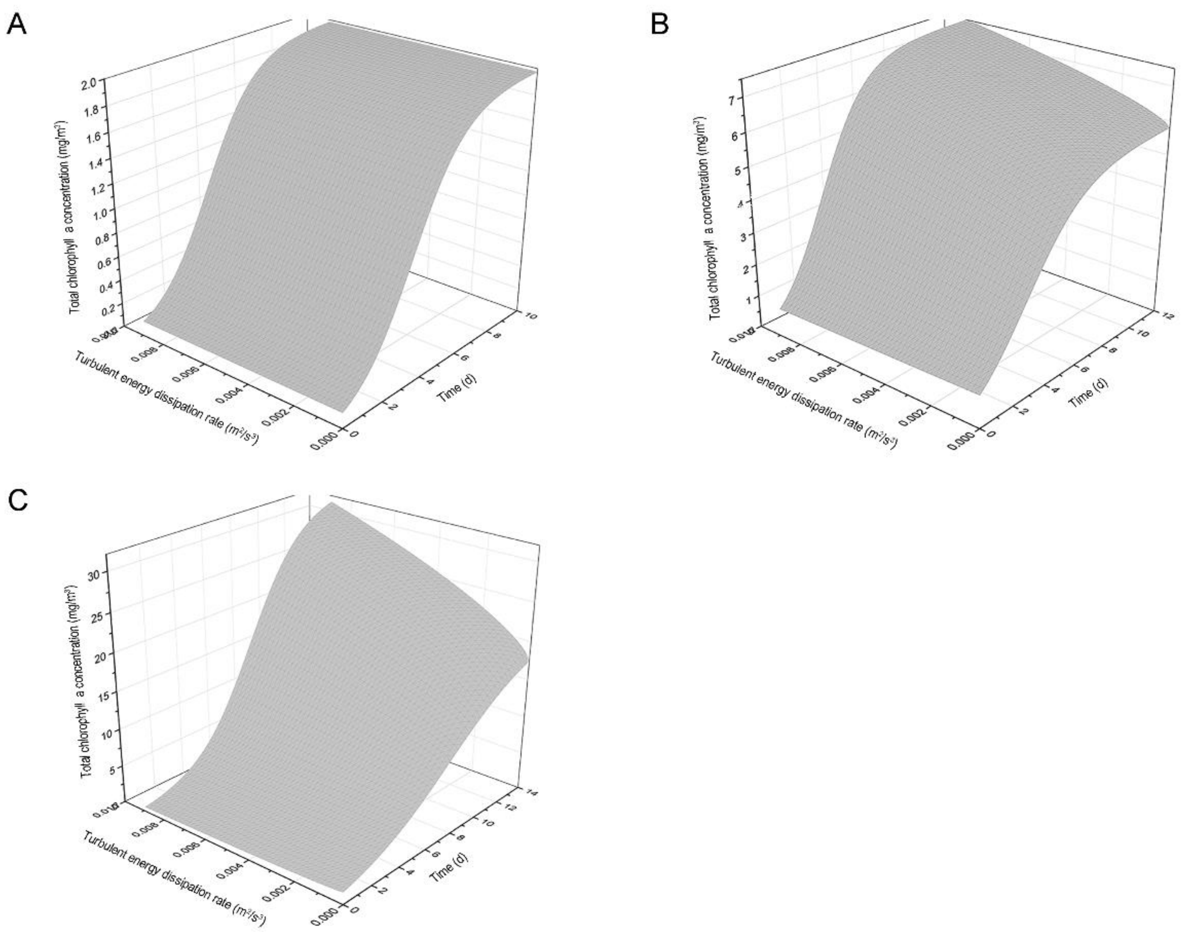

Fig.4 Three-dimensional diagram of turbulent energy dissipation rate-time-chlorophyll-a concentration (2.5 mg/L, 5 mg/L, 15 mg/L; A, B & C).

Conclusions

The study explores a mechanism of the interaction of TN concentration and turbulence intensity on algal growth. It posits that the change of metabolism activity (e.g., chlorophyll-a) induced by the interaction of TN and turbulence causes an increase in algal density, which could lead to algal blooms in eutrophic lakes. And effective microalgae cultivation methods can be developed for harvesting bioenergy through considering the optimal culture conditions used in the current study.