

Effect of some nutrients and their combinations on the growth of
Ankistrodesmus falcatus

Rameses R. ABDALLA*, Esha EL-AUYTI** and Zeinab M. EL-SHERIF*
*National Institute of Oceanography and Fisheries, Alexandria (Egypt)
**Botany Department, Faculty of Science, Cairo University (Egypt)

INTRODUCTION.

The purpose of this work is to investigate some algal nutrient relationships. The regression coefficient was used as a measure of the relationship between two dependants or more excluding the influence of a certain number of other physical and chemical factors which might simultaneously affect the variables considered. This paper is dealing with the effect of N, P, Fe and their intereffects on the growth of *Ankistrodesmus falcatus* var. *mirabile* W. & G.S. West.

MATERIAL AND METHODS.

The alga was cultured in modified Chu 10 solution, by adding the cations as chloride salts and the anions as sodium salts (Chu, 1942). The complementary effect of the three variables was evaluated by applying central-composite rotatable design (Cochran & Cox, 1957) where each factor varied at 5 levels (-1.682, -1, 0, +1, +1.682). The scale of neutral variable change was chosen to be logarithmic, so the real element concentration was as follows: N(0.5, 1, 3, 9, 19 mg/l), P(0.214, 0.4, 1, 2.5, 4.67 mg/l), Fe (0.053, 0.1, 0.253, 0.64, 1.21 mg/l). Experiments were performed in triplicates. Cultures were grown in incubator at light intensity 5 K lux and temperature of 25 ± 1°C.

RESULTS AND DISCUSSION.

Equations (1-4) represent the regression models describing the dependence of culture growth (Y) cell/ml on the different concentration levels of N, P, and Fe for the different days of experiment.

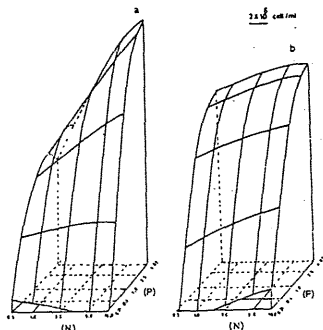
$$Y_4 \cdot 10^6 = 8623 + 797 X_N - 121 X_F - 126 X_{PF} - 1618 X_N^2 - 643 X_P^2 - 665 X_F^2 \quad (1)$$

$$Y_6 \cdot 10^6 = 14929 + 2485 X_N - 403 X_{NF} - 935 X_{NPF} - 3067 X_N^2 - 1483 X_P^2 - 867 X_F^2 \quad (2)$$

$$Y_8 \cdot 10^6 = 16811 + 6003 X_N + 1642 X_P + 818 X_{NP} - 562 X_{PF} - 926 X_{NPF} - 1981 X_N^2 - 131 X_P^2 - 667 X_F^2 \quad (3)$$

$$Y_{10} \cdot 10^6 = 18133 + 7992 X_N + 1386 X_P + 1097 X_{NP} - 1168 X_N^2 - 1308 X_P^2 - 693 X_F^2 \quad (4)$$

For the second day of growth (Y₂), it was not possible to obtain adequate model. This may be attributed to the lag phase of growth during that time. The analysis of data showed that, all over the time of experiment, cultures were mainly affected by the simple linear regression effect of N. The effects of P and Fe were missed during some days of growth. This does not mean that at that particular time, P or Fe has no effect on algal growth, their effect can be easily detected through their intereffect for either one with the other or with N. Cultures were also affected by 2 unlike intereffects, the positive intereffect of N with P and the negative one of P with Fe. The synergistic effect of simultaneous N and P addition on culture growth has been discussed by several authors (Gatham & Rhee, 1981 a, b; Abdalla, 1986), increasing nitrate concentration in culture media stimulates both N and P uptake by algal cells, establishing different amounts of cell N and P needed for cell division. The natural intereffect of P with Fe on algal growth is positive (Abdalla, 1986; Abdalla et al., 1986). The unexpected negative nature in our case can be attributed to the fact that the concentration level for P and Fe used in this experiment was too high compared with the levels used in the previous mentioned papers. From the chemical point of view, in alkaline medium, the unchelated ferric ion, when the phosphate at a high level, enhances the formation of insoluble ferric phosphate, lowering iron concentration, which negatively affects culture growth. The results of the present investigation show that the influence of variables acting together (interaction effects) are more important in understanding the dependence of culture growth on the concentration levels of nitrogen, phosphorus and iron. The relationship between algal growth and the concentration of N and P at the 8th day of growth is illustrated in Fig. a, where iron is at a level of (-1)0.1 mg/l while Fig. b represents the same relationship when iron at the higher level (+1) 0.64 mg/l.



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The winter Phytoplankton of the North Suez Canal, January 1990

M.-M. DORGHAM

Oceanography Department, Faculty of Science, Alexandria University (Egypt)

Phytoplankton as well as other organisms of the Suez Canal in general and Port Said in particular, is attractive to the marine biologists. The importance of Port Said area comes from being the northern entrance of the Suez Canal, the biota of which is affected by the northward current passing the Canal from October to July and reaching its maximum in winter (MORCOS, 1967). Such current carries the plankton organisms from the Indo-pacific Red Sea habitat to the Atlanto-Mediterranean habitat, and though facilitates the immigration of species between the two habitats.

During January 1990, samples were collected from 7 stations distributed inside the Canal, in the Harbour and outside the Harbour. Qualitative samples were collected by oblique hauling of a fine net with 55 µm mesh size, and the quantitative samples (one litre each) were collected from the surface water by Niskin bottle.

The winter (January) phytoplankton of Port Said was composed of 73 taxa of diatoms and 64 taxa of dinoflagellates. Remarkable number were neritic or littoral. The phytoplankton community was dominated by the diatoms: *Nitzschia delicatissima*, *Lithodesmium undulatum*, *Chaetoceros curvisetum*, *Ch. decipiens*, *Leptocylindrus danicus*, *Rhizosolenia stouterfithii*, *Thalassiothrix frauenfeldii*, *Coscinodiscus gigas* and *Cyclotella meneghiniana*. Some of dinoflagellates were common such as *Ceratium furca*, *C. lineatum*, *C. egyptiacum* and *Protoperidinium cerasus*. Several brackish and fresh water forms were observed in the area possibly transferred from the adjacent Lake Manzalah. The distribution pattern of phytoplankton species in Port Said showed obvious homogeneity among the stations, but with different abundances. Such homogeneity is attributed to the current regime in the Canal during winter (DOWIDAR, 1976).

In the water samples, the standing crop varied between 30636 cells l⁻¹ and 890000 cells l⁻¹ with an average of 349275 cells l⁻¹. The lowest crop was observed at the proper Mediterranean stations, while the highest crop was found near the inlet of the brackish water to the Canal. The leading species of the standing crop were *Nitzschia delicatissima* forming 36-71% of the total crop, *Skeletonema costatum* (5-25%), *Cyclotella meneghiniana* (18-19%) and *Leptocylindrus danicus* (5-7%).

The species composition and the standing crop of phytoplankton in Port Said varied significantly from those recorded by DORGHAM (1974) and DOWIDAR (1976). These variations are related to changes in factors acting in the Canal during the past two decades, such as increase of oil pollution and water disturbance due to the ship movements in the Canal and the widening processes of the Canal.

The most characteristic feature of the winter phytoplankton was the existence of several species, which were recorded by HALIM (1970) and DOWIDAR (1976) as Red Sea immigrants, namely: *Coscinodiscus gigas*, *Biddulphia sinensis*, *Ceratium breve* and *C. egyptiacum* in addition to *Rhizosolenia shrubsolei*, *R. alata*, *R. calcar-avis* and *Quinardia flaccida*, which might be also Red Sea immigrants, particularly in winter. Moreover, other Indo-pacific forms such as *Hemidiscus hardmanianus*, *Ceratium schmidtii*, *C. lineatum*, *C. recurvatum*, *Protoperidinium ovatum* and *P. conicum* v. *assamushii* were not recorded previously in the study area or in the eastern Mediterranean. Some of these species were found in significant density in the net samples. Therefore, they may be regarded as immigrants from the Red Sea. STEINITZ (1968) stated that introduction of individuals of species already represented in the involved area is immigration at least from the numerical point of view.

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