INTRODUCTION

Several attempts have been made in the literature to describe mathematically the relationship between light intensity and photosynthesis. A review on the subject can be found in Platt, Denman and Jasby (1977). The models up to now have been empirical. The aim of our effort is to present a simple mathematical description of the photochemical processes that will also make it possible to calculate the integral photosynthesis of a water column. Below, the main features of the model formulation are given. A more detailed description will be published elsewhere.

DESCRIPTION OF THE MODEL

The model assumes that a photosynthetic unit (PSU) can be in three states: (a) a rest-state; (b) activated by one photon; (c) de-activated by more photons. The state (c) describes the effect of photo-inhibition the inactivation of PSU's by a too fast succession of photons (Kok, 1956; Kok et al., 1965).

Transition from one state to another occurs when a PSU is hit by a photon. We assume a Poisson chance-model (independent waiting times between hits) and a hit rate proportional to the light intensity. The steady state distribution is derived, from which the following relation results:

\[ p = \frac{I}{aI^2 + bI + c} \]

where \( p \) = photosynthesis rate, \( I \) = light intensity, \( a, b, c \), = parameters.

The parameters values do not follow from the theory; they have to be fitted for real measurements. A picture of the general shape of this relation is given by Fig. 1, where some characteristics that lend themselves to easy interpretation, are also indicated. They are:

\[ S = \text{initial slope} = \frac{1}{c} = \tan \phi \]

\[ p_m = \text{maximum value of} \ p = \frac{1}{b + 2\sqrt{ac}} \]

\[ I_m = \text{intensity at which} \ p_m \text{occurs} = \sqrt{\frac{c}{a}} \]
Fig. 1, Characteristic parameters of the production curve.

\[
I: \quad p = \frac{1}{aI^2 - bI + c}
\]

\[
II: \quad p = 2 \left(1 + \beta \right) \frac{(I/I_m)}{(1/I_m)^2 + 2\beta (1/I_m) + 1}
\]

Fig. 2, A typical fitted production curve.

By introducing a new variable \(x\) and a new parameter \(\beta\)

\[
x = \frac{I}{I_m}
\]

\[
\beta = \frac{b}{2\sqrt{ac}}
\]