NUTRIENT INPUT BY THE PHOTOSYNTHETIC AQUATIC BIOMASS IN A RICEFIELD AND ITS CONTRIBUTION TO THE MAINTENANCE OF SOIL MICROBIAL BIOMASS

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1. Introduction, purpose of the study

The photosynthetic aquatic biomass (PAB) that develops in ricefield floodwater is composed of planktonic filamentous, and macrophytic algae, and vascular macrophytes. These primary producers constitute one of the sources of organic nutrients that allow the replenishment of the microbial biomass and available nitrogen in wetland rice soils. A conceptual scheme of the pathways involved in this replenishment is presented below. The purposes of the experiment were (1) to establish, from large number of measurements under various management practices, the ranges of nutrient contributions by the PAB; and (2) to study how suppressing photosynthetic activity in ricefield floodwater affects soil microbial biomass.

2. Materials and methods

Measurements were made in the 65 plots (4x4 m) of a long-term experiment established in 1985 in IRRI's farm. The main treatments were N-fertilizer (none; 30+25 kg urea-N/ha broadcast; 55 kg N/ha deep-placed). Other treatments were the method of P application, algid inoculation, and control of algid predators. Quantitative measurements involving PAB included:

- composition and standing crop of main components of the PAB, estimated on composite samples in each plot;
- photosynthetic activity, estimated as gross primary production in C/m²/day from 24-h measurements of dissolved O₂ (DO), water temperature, and water depth (a graphic summarization of the method used is presented with the results); and
- photo-dependent acetylene reducing activity (ARA) (nmol C₂H₂/m²/h), measured on composite samples of 8 cores (2 cm depth) including floodwater algae and the first 2-3 cm of soil. Cores were incubated under 10% acetylene in air for 1 h in a light chamber (30 lux, 28-30 °C). Acetylene/N₂ ratio was 4.7 ± 0.7 (average of 5 estimates).

To study the effect of suppressing photosynthetic activity in floodwater on soil microbial biomass, a metallic frame (1 x 1 x 0.5 m) was inserted in 1987 in each plot and covered with black cloth inserted between two planks of polyurethane foam. The cover had holes to allow rice growth. The effect of weed incorporation versus removal was also tested. A greenhouse experiment also compared microbial biomass of the unplanted, flooded soil, either exposed to light or kept in the dark for one year. Soil microbial biomass was estimated as flush-N (ppm NH₄-N of fresh soil) obtained by chloroform treatment followed by 4 weeks of anaerobic incubation.

3a. Standing crops of PAB components*

3b. Gross primary production

A study of 195 diurnal cycles showed no marked changes in temperature, photosynthetic activity, estimated as gross primary production and maximum O₂ in water during a crop (DS 88) in which no marked changes in temperature occurred. This allows extrapolations from single O₂ measurements.

4. Summary and conclusions

- Algae and small floating macrophytes (500 estimates over one season) had standing crops averaging 5 kg N and 30 kg C/ha over the crop cycle. Maximum values recorded during each crop cycle were about twice as high.
- Weeding permitted the recycling of an average 8 kg N/ha per crop and 200 kg C/ha per crop (65 estimates over one season) added during the crop cycle.
- Gross primary production in water over the crop (130 estimates over 3 seasons) ranged from values equivalent to 2 to 50 kg N fixed/ha.
- A study of 195 diurnal cycles showed no marked changes in temperature, photosynthetic activity, estimated as gross primary production and maximum O₂ in water during a crop (DS 88) in which no marked changes in temperature occurred. This allows extrapolations from single O₂ measurements.

3c. Photodependent N-fixation

4. Summary and conclusions

- Each value is the average of 9 to 13 ARA measurements during a crop cycle. The bimodal histogram results from NIF inhibition in plots where urea was broadcast. Ten nmol C₂H₂/m²/h over a cropping season is roughly equivalent to 1 kg N fixed/ha.

3d. Soil microbial biomass (flush-N)

- ARA: acetylene reducing activity
- EDY: dry season
- WS: wet season
- DT: days after transplanting
- ISO: dissolved oxygen

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