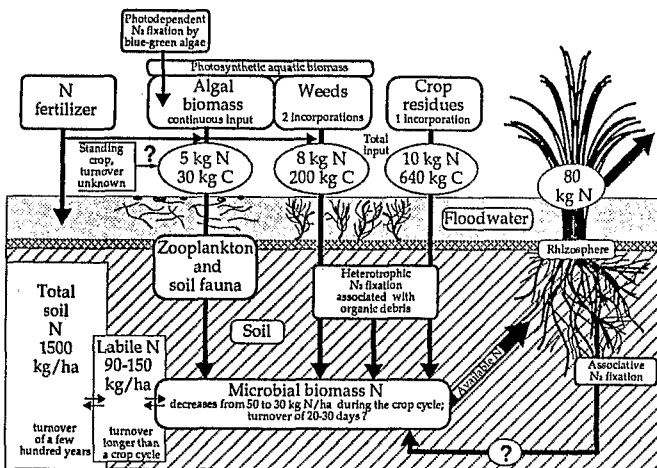


NUTRIENT INPUT BY THE PHOTOSYNTHETIC AQUATIC BIOMASS IN A RICEFIELD AND ITS CONTRIBUTION TO THE MAINTENANCE OF SOIL MICROBIAL BIOMASS

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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 are 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 numbers 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 on IIRRI's farm. The main treatment is N-fertilizer: (none; 30+25 kg urea-N/ha broadcast; 55 kg N/ha deep-placed). Other treatments were: the method of P application, algal inoculation, and control of algal predators. Quantitative measurements involving PAB included:

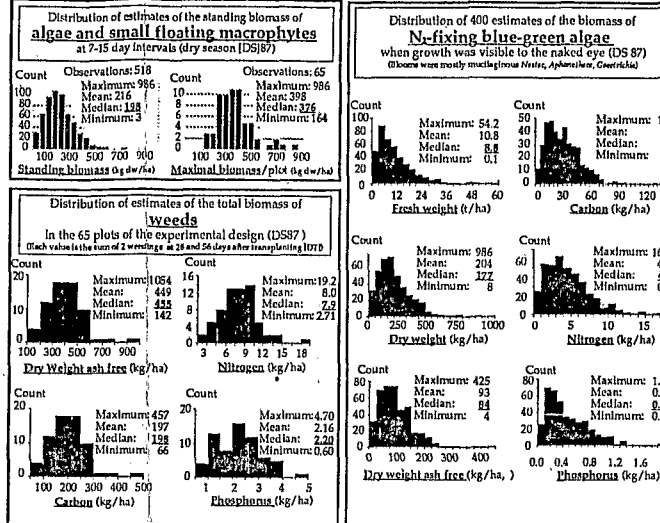
- composition and standing crop of main components of the PAB, estimated on composite samples in each plot;
- photosynthetic activity, estimated as gross primary production in $g\ C/m^2/day$ from 24-h measurements of dissolved O_2 (DO), water temperature, and water depth (a graphic summarization of the method used is presented with the results); and
- photodependent acetylene reducing activity (ARA) ($\mu mol\ C_2H_4/m^2/h$), measured on composite samples of 8 cores (2 cm ϕ) 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 klux, 28-30 °C). Acetylene/ N_2 ratio was 4.7 ± 0.7 (average of 5 estimates).

To study the effect of suppressing photosynthetic activity in the 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 plaques of polystyrene 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.

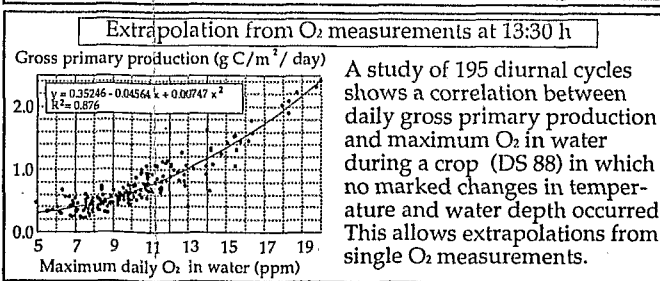
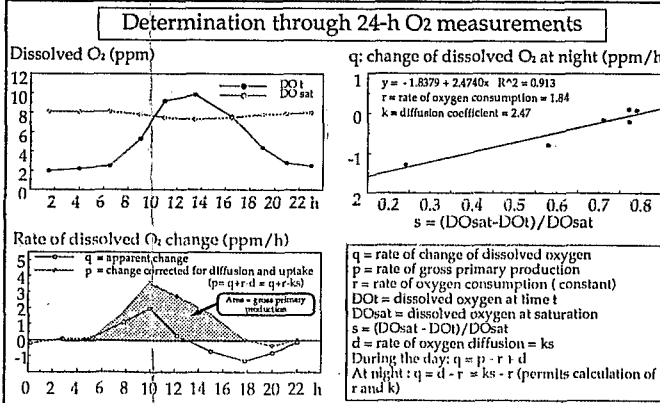
Soil microbial biomass was estimated as flush-N (ppm NH_4-N of fresh soil) obtained by chloroform treatment followed by 4 weeks of anaerobic incubation.

3a. Standing crops of PAB components*

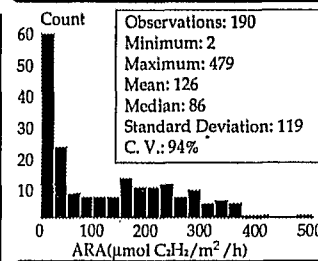


*DS 1987. Mucilaginous N-fixing blue-green algae were the dominant component of algal populations.

3b. Gross primary production



3c. Photodependent N_2 -fixation



Each value is the average of 9 to 13 ARA measurements during a crop cycle. The bimodal histogram results from BNF inhibition in plots where urea was broadcast. Ten $\mu mol\ C_2H_4/m^2/h$ over a cropping season is roughly equivalent to 1 kg N fixed/ha.

3d. Soil microbial biomass (flush-N)

Effect of management of photosynthetic aquatic biomass on soil microbial biomass, DS & WS 1988*

	Soil	Weeds incorporated	Weeds removed	Dark control	Variance analysis**
Dry season 1988					
27 DT	0-2 cm (ppm)	47.7	47.7	37.5	1%
	before 2-7 cm (ppm)	41.8	41.8	28.1	1%
	deeper soil (1-4cm) (ppm)	44.2	44.2	30.3	1%
Wet season 1988					
76 DT	0-2 cm (ppm)	36.2	34.5	23.6	5%
	2-7 cm (ppm)	28.2	27.8	26.9	ns
	0-7 cm (kg/ha)	30.9	30.1	25.8	5%
91 DT	0-2 cm (ppm)	36.4	39.9	25.3	1%
	2-7 cm (ppm)	26.5	26.2	25.9	ns
	0-7 cm (kg/ha)	29.7	30.4	25.5	1%
Mean 0-7 cm (ppm)					
		35.2	34.2	28.2	1%

*Value are mean of duplicate measurements on a composite sample of 20 cores collected from 10 replicated plots. **Level of significance. **ppm NH_4-N , fresh soil basis.

Comparison of total N content and microbial biomass of unplanted, flooded soil exposed to light or kept in the dark for one year*

	Total N (% soil dw)	Microbial biomass (% soil dw)	(% soil N)
Soil exposed to light			
Initial N content	0.168 c		
1* cm	0.249 a	97.6 a	3.9 a
deeper soil (1-4cm)	0.168 c	51.3 b	3.0 b
Soil kept in the dark			
Initial N content	0.180 b		
1* cm	0.161 c	30.4 c	1.9 c
deeper soil (1-4cm)	0.151 c	27.7 c	1.8 c

*Greenhouse experiment in 0.5×0.5 m microplots with 5 cm of soil. In plots exposed to light, algae and weeds were reincorporated every 2-3 weeks. Values are average of duplicate measurements in 10 replicated plots.

Abbreviations:
 ARA: acetylene reducing activity
 DS: dry season; WS: wet season
 DT: days after transplanting
 DO: dissolved oxygen

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).
- Gross primary production in water over the crop (130 estimates over 2 seasons) averaged $0.75\ g\ C/m^2/day$. These values are similar to those in eutrophic lakes and correspond to about 10-15 % of the gross primary production of rice.
- Average ARA per plot (190 estimates over 3 seasons) ranged from values equivalent to 2 to 50 kg N_2 fixed/ha / crop. When ARA was not inhibited by broadcast urea it averaged 20-30 kg N_2 .
- After one year of submersion of an unplanted soil, microbial biomass (flush-N) was about 60% lower in the first soil cm and 50% lower in the deeper (1-4 cm) layer when soil was kept in the dark as compared with soil exposed to light.
- In the field, weed removal and light elimination significantly decreased soil microbial biomass after two crops. Microbial biomass was about 22% lower in the dark control than in the light treatment with weeds incorporated. The effect was more marked in the upper soil layer (0-2 cm) than in the deeper soil layer. N fertilizer had little effect on flush-N (data not shown).
- In wetland ricefields, the photosynthetic aquatic biomass constitutes a major component and source of nutrients for the microbial biomass in the upper soil layer and a significant source of nutrients for the microbial biomass in deeper soil.

18 MARS 1991

ORSTOM Fonds Documentaire

N° : 31.517-ex 1

Cote : B

P20