NITROGEN FIXATION UNDER RICE FIELD CONDITIONS

THE maintenance of the fertility of rice field soils for many years, without the application of fertilizers, is largely due to the microbial fixation of atmospheric nitrogen[1-2]. Among the diversified groups of micro-organisms recognised as nitrogen fixers under rice field conditions, *Azotobacter*, *Beijerinckia*, *Clostridium* and blue green algae are important[3]. Soils of low-land rice fields offer a unique ecological situation with both aerobic and micro-aerophilic conditions[4]. Recently a noteworthy phenomenon has been reported by the workers at the International Rice Research Institute in the Philippines. According to them rhizosphere microorganisms of rice plant play a very significant role in nitrogen fixation[1,5]. The observations of Dommergues *et al.*[7], through studies under tropical conditions, also confirmed this finding. The present communication examines the nitrogen fixing activity of rice crop under water-logged soils in Tamil Nadu.

A field experiment was conducted at the wetlands of Tamil Nadu Agricultural University, Coimbatore, with the rice varieties IR-20 and Bhavani raised with the recommended dose of fertilizers (60 N, 30 P and 30 K kg ha). At different stages of the crop, the rhizosphere, rhizoplane and non-rhizosphere soil samples were collected and placed in 500 ml Ehrlenmeyer flasks fitted with rubber needle puncture stoppers. Field water samples from different locations of the wetlands were also collected and taken in 20 ml rubber stoppered vials. Air in the vessels was replaced by a mixture of nitrogen and oxygen (4 : 1) and pure acetylene was injected with a Hamilton gas tight syringe to obtain *ca.* 0·05 atm. The vessels containing the rice roots were maintained at an acetylene concentration of 0·3 atm as rice roots exhibit higher nitrogenase activity only at that partial pressure of acetylene[8]. To study the contribution of the photosynthetic micro-organisms towards nitrogen fixation, one set of samples was incubated under day light (*ca.* 30,000 lux) for 6 hrs.

The nitrogen fixation was studied by using the acetylene reduction technique[1]. A Perkin Elmer Model F-33 Gas Chromatograph fitted with a flame ionization detector, Porapak-N column (80–100 mesh) and a Perkin Elmer Model 56 recorder served the purpose of assaying nitrogenase. All samples were incubated at 28° C ± 1 for 24 hrs.

The data (Table I) reveal that under rice field conditions nitrogen fixation takes place under dry as well as wet conditions. The latter, however, recorded greater nitrogenase activity, because under flooded conditions many of the heterotrophs become more active than they are in the dry soil. The data further reveal that under illuminated conditions there was more N-fixation than under darkness, indicating the role of photosynthetic nitrogen fixing microorganisms[8,9]. They warrant immediate attention for better exploitation.

TABLE I

Nitrogen fixation under rice field conditions

Samples	Incubation under	
	Darkness	Illumination
Rice field water*	10·60	17·95
Rice field soil (air dried)†	12·52	15·79
Rice field soil (water-logged)†	205·00	320·00

* nm of C_2H_4 formed/100 ml of water/24 hr.

† nm of C_2H_4 formed/kg of soil/24 hr on dry weight basis.

(Mean of ten samples collected at random)

TABLE II

Nitrogen fixation under wetland conditions in two rice varieties, IR-20 and Bhavani*

(Incubated under darkness)

Stage of the crop	Nitrogen fixation					
	Rhizosphere soil		Non-rhizosphere soil		Rhizoplane	
	Bhavani	IR-20	Bhavani	IR-20	Bhavani	IR-20
Seedling	42·00	19·00	12·00	7·00	22·80	14·00
Tillering	23·60	21·00	14·00	5·00	46·50	16·80
Boot-leaf	65·00	54·00	22·00	14·00	102·00	67·80
Flowering	95·00	64·00	18·00	8·00	86·50	71·00

(Data represent average of three estimations.)

* nm of C_2H_4 formed/100 g of soil or per g of root/24 hr.

TABLE III

Nitrogen fixation under wetland conditions in two rice varieties, IR–20 and Bhavani*
(Incubated under Illumination)

Stage of the crop	Nitrogen fixation					
	Rhizosphere soil		Non-rhizosphere soil		Rhizoplane	
	Bhavani	IR–20	Bhavani	IR–20	Bhavani	IR–20
Seedling	84·00	24·00	18·60	11·00	48·00	40·00
Tillering	46·00	52·00	22·60	16·00	53·00	65·00
Boot-leaf	136·00	76·00	38·60	18·00	72·00	190·00
Flowering	164·00	96·00	36·00	14·00	220·00	180·00

(Data represent average of three estimations.)

* nm of C_2H_4 formed/100 g of soil or per g of root/24 hr.

The two rice varieties, IR–20 and Bhavani recorded distinct differences in their nitrogen fixing capacity not only in respect of the rhizosphere but also of rhizoplane regions. In general, Bhavani registered greater N fixation activity than IR–20. At boot-leaf and flowering stages, both the varieties recorded greater activity than at any other stage. This observation adds additional evidence to our earlier finding that at boot-leaf and flowering stages of rice crop, the *Azotobacter* population was maximum in the rhizosphere[10]. In both the varieties the rhizoplane and rhizosphere samples exhibited greater nitrogenase activity than the soil farther apart. This amply illustrates that rhizosphere and rhizoplane of rice crop are much more important in nitrogen fixation than they are presumed to be. Yet another important finding of the study is that when the samples were incubated under light, better nitrogen fixation was stimulated. This could be due to (i) the contribution by photosynthetic N-fixers, (ii) through greater CO_2 fixation more of carbohydrates might have been made available to the organisms at the root zone, (iii) the possible diffusion of nitrogen into the rhizosphere region. The qualitative and quantitative changes in the microflora accompanying different growth phases of the crop need to be assessed with different rice varieties.

Microbiology Laboratory,
Tamil Nadu Agricultural
University,
Coimbatore 641 003,
September 6, 1977.

D. PURUSHOTHAMAN.
N. DHANAPAL.
G. RANGASWAMI.

1. Yoshida, T. and Ancajas, R. R., *Soil Biol. Biochem.*, 1973, **5**, 153.
2. Stewart, W. P. D. (Ed.) *Nitrogen Fixation by Free-Living Microorganisms*, IBP, Cambridge University Press, Cambridge, 1975, p. 471.
3. Yomaguchi, M., In : *The Fertility of Paddy Soils and Fertilizer Application for Rice*, Food and Fertilizer Technology Centre for Asia and Pacific Region, Taiwan, 1976, p. 60.
4. Yoshida, T. In : Paul, E. A. and McLaren, A. D. (Ed.), *Soil Biochemistry*, Marcel Dekker, New York, 1975, p. 83.
5. — and Ancajas, R. R., *Proc. Soil, Sci. Am.*, 1970, **35**, 156.
6. Dommergues, Y., Balandreau, J., Rinaudo, G and Weinhard, P., *Soil Biol. Biochem.*, 1973 **5**, 83.
7. Yoshida, T. and Ancajas, R. R., *Soil Sci. Plant Nutrn.*, 1970, **16**, 234.
8. Stewart, W. D. P., *Annu. Rev. Microbiol.*, 1973 **27**, 283.
9. Takahashi, H. (Ed.), *Nitrogen Fixation and Nitrogen Cycle, JIBP Synthesis*, University Tokyo, 1975, **12**, 161.
10. Purushothaman, D., Oblisami, G. and Balasundaram, C. S., *Madras agric. J.*, 1976, **63**, 595.

A NEW PENTATOMID HOST FOR A PTEROMALID EGG PARASITE AND THE NATURE OF INTERSPECIFIC COMPETITION WITH OTHER HYMENOPTEROUS EGG PARASITES

REPORTS on the incidence of pteromalid parasites on the eggs of pentatomids are meagre, the only known parasites being *Pachyneuron pentatomivora* Mani, *Acroclisoides indicus* Ferr., *A. major* Gir. Though