Role of algalization in rice growth, yield and incidence of infestation with the stem borer *Chilo agamemnon* Bles. and the leaf miner *Hydrellia prosternalis* Deeming in the Nile Delta

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Blue-green algae as a soil-based inoculum was applied to short-duration Indica rice in combination with 72 kg N/ha and compared with just N fertilization applied as 144 kg N/ha. Fertilizer N was applied in two equal doses 25 days after transplanting and at mid-tillering stage. The algal inoculum, which contained *Anabaena cylindrica*, *Anabaena oryzae*, *Nostoc muscorum* and *Tolyphothrix tenuis*, was applied at 100 kg/ha fresh material (90% moisture) 5 days after transplanting. Five different combinations of microelements were sprayed as a foliar application simultaneously with fertilizer N. Plant performance was enhanced by inoculation with algae and microelements compared with complete N fertilization only. Natural infestation with the stem borer, *Chilo agamemnon*, and leaf miner, *Hydrellia prosternalis*, decreased significantly during growth and up to harvesting with application of algae, Endosulfan, and increased with application of microelements.

Many trials on algal inoculation have been conducted in rice growing countries and algalization of rice fields with soil-based inoculum of blue-green algae had been recommended (Venkataraman 1981). In the northern Nile Delta, algalization trials started in 1970, but only moderate progress has been achieved because algalization was considered as just a means for saving a portion of fertilizer nitrogen. The other benefits which may be achieved by algalization, such as stimulation of plant growth and improved properties of the rice ecosystem, were not considered. Some of these benefits have been recorded by Gupta & Lata (1964), Venkataraman & Neelakantan (1967), Vaidya (1970), Jacq & Roger (1977), Venkataraman (1981) and Yanni et al. (1988 a,c).

During the past five years, many trials on algalization have been carried out in the northern Nile Delta (Yanni et al. 1988 a,b,c). Substituting one-third to one-half of the recommended fertilizer N by 100 kg of a soil-based inoculum of blue-green algae (90% moisture)/ha, propagated in the same rice field increased the rice yield above that achieved by the critical high N fertilization rate for maximum yield. Additionally, a considerable decrease in the infestation by some rice pests, such as blast, stem borer, leaf miners and weeds, was recognized in fields inoculated with algae. To investigate this effect further, a series of field experiments has now been conducted in the northern Nile Delta and this paper reports the results of the experiments in which infestations of rice with the stem borer, *Chilo agamemnon*, and the leaf miner, *Hydrellia prosternalis*, have been followed under various regimes of N fertilizer and trace elements applications being compared with the benefits produced by inoculation with blue-green algae. The stem borer is a very serious pest in rice production in Egypt and drastic losses in yield have occurred in some fields since 1986. The concomitant introduction of the Indica rice varieties has intensified this problem as they are highly susceptible to stem borers and leaf miners compared with the Japonica types (Tantawi et al. 1985). Chemical control of the borers by insecticides was unfortunately also toxic to fish which occur in the rice fields (El-Basyouni et al. 1988).
Materials and Methods

A field experiment was conducted at Sakha Agricultural Research Station, Kafr El-Sheikh, A.R. Egypt during the summer season of 1988 using Indica rice variety IR 28, which has a short growing season (135 days) and is highly responsive to N fertilizer. The experiment was conducted in split-plot design with two main treatments, six sub-treatments and four replicates. The net area of the subplot was 4 x 5 m. The soil type was clay-loamy alluvial soil: pH, 8.6; electrical conductivity, 0.82 mmho/cm; organic matter, 2.5%; N, 0.11%; P, 938 ppm; Zn, 1.32 ppm. Gross composition (w/w) 54% clay, 22% silt and 20% sand. Dates of sowing, transplanting and harvesting were 15 May, 14 June and 28 September, respectively. Transplanting density was 2 to 3 seedlings at the centre of a 20 x 20 cm square. The main plot treatments were nitrogen fertilization as urea (46% N) was at 144 kg N/ha (144 N), or algalization with soil-based inoculum of blue-green algae (BGA), applied at 100 kg fresh inoculum (90% moisture)/ha, plus N fertilization at 72 kg N/ha (BGA + 72 N). Fertilizer N was applied in two equal doses, 25 days after transplanting and at mid-tillering. The algal inoculum was produced at the same experimental field using a shallow soil pit 1 x 10 x 0.2 m. The soil was layered with a thick polythene sheet and 200 kg soil added to the pit to a depth of 10 cm. The soil was irrigated and the water level was maintained at 3 to 5 cm over the soil surface. One day later, the system was inoculated by a starter of 240 g of a dried soil-based inoculum of blue-green algae (SBI-BGA) prepared using equal dry weights of Anabaena cylindrica, Anabaena oryzae, Nostoc muscorum and Tolypothrix tenuis. After 10 days, about 30 kg fresh algae (90% moisture) was collected. The algal nursery bed was then re-irrigated and harvested every 10 days; 200 g fresh algae were used to inoculate the concerned subplots 5 days after transplanting (this quantity is equivalent to 100 kg fresh SBI-BGA/ha).

Subplot Treatments

Five microelement compounds were used for foliar application of rice 30 and 50 days after transplanting. Chemical analysis of the compounds and rates of application were: Foliatin (1.8 l/ha): N, 11%; P, 6.5%; K, 2.5%; Zn 1100 ppm; Fe, 1300 ppm; Mn 1000 ppm; Cu, 500 ppm; with Mg, Mo, Co, Ni traces. Woxal-micro-Zn (0.8 kg/ha): N, 13.7% (6.7% NH2-N and 7% NH4-N); Zn, 4%; Fe, 1.37%; B, 0.013%; Mn, 2.7%; Mo, 0.006%; Co, 0.006%; Cu, 0.013%; in chelating compounds and Vitamin B1 traces. Woxal 1-2-4-1 (0.8 kg/ha): N, 20%; P, 3%; K, 3%; Fe, 0.2%; Mn, 0.26%; Cu, 0.012%; Mn, 0.006%; Co, 0.006%. Agrosone (1 l/ha): mainly a microelement and bacterial preparation. Metalosite (0.48 l/ha): Zn, 0.5%; Fe, 0.5%; Mn, 0.5%; Cu, 0.5%; Ca, 1%; Mg, 1%; and amino acids preparation as chelating compounds.

Thirty days after transplanting, natural infestation with the rice stem borer, Chilo agamemnon, and rice leaf miner, Hydrellia prosternalis, were recognized. The field was treated by Endosulfan (6,5,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin 3-oxide—trade name Thiodan) at the rate of 10 kg/ha for treatment of the two pests. Similar, but micro, subplots (2 x 2.5 m) of the entire experiment were established and left without insecticide treatment for a check. The severity of natural infestation with the stem borer, indexed by stems showing dead heart symptoms, was examined weekly for three successive weeks. Two examinations were made for the leaf miner, 30 and 45 days after transplanting. White heads due to infestation with the stem borer and partially infested tillers (plants with infested stems and sound heads) were estimated at harvest stage. Yield losses due to borer infestation were calculated using the formula introduced by Isa et al. (1970) as follows:

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\text{% loss in yield} = \frac{D + W + S}{10} \times 10
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