41

Impact of insecticides on herbivore-natural enemy communities in tropical rice ecosystems

K.L. Heong and K.G. Schoenly

INTRODUCTION

Today, rice pest management in tropical Asia is strongly influenced by the agrochemical era of the 1960s and 1970s. Prophylactic insecticide campaigns were components of rice production intensification programmes, like Masagana 99 in the Philippines (Alix, 1978) and BIMAS in Indonesia (Adjid, 1983). Through agricultural subsidy and loan schemes, farmers were encouraged to apply insecticides on regular schedules (Kenmore *et al.*, 1987; Conway and Barbier, 1990; Conway and Pretty, 1991). The agrochemical industry, through its aggressive advertising and marketing campaigns, also played a role in encouraging pesticide use.

The pest problems farmers and researchers witnessed in tropical Asia in the 1970s, particularly insecticide-induced outbreaks of the rice brown planthopper (*Nilaparvata lugens* Stål [BPH]; Heinrichs and Mochida, 1984; Kenmore *et al.*, 1985), led to IPM strategies that emphasized host-plant resistance, biological control and cultural practices, minimizing the use of pesticides. Since the 1970s however, several studies in tropical Asia have concluded that high levels of host-plant resistance for BPH management are unnecessary under certain circumstances (i.e. large areas of irrigated rice production where farmers use of insecticides is low). Experimental

Ecotoxicology: Pesticides and beneficial organisms.
Edited by P.T. Haskell and P. McEwen. Published in 1998 by Chapman & Hall, London. ISBN 0 412 81290 8.

studies conducted in Indonesia, Vietnam and the Philippines, for example, have shown that (a) hopperburn is rare or absent in fields grown with BPH-susceptible varieties not treated with insecticides (Kenmore *et al.*, 1984; Cook and Perfect, 1985; Cuong *et al.*, 1997: but see Sawada *et al.*, 1993); (b) susceptible varieties rarely show yield loss by BPH populations even when outbreaks occur in adjacent plots (Cuong *et al.*, 1997); and (c) moderately-resistant or even BPH-susceptible varieties grown for several years by a large number of farmers are associated with low and stable BPH populations (Gallagher *et al.*,1994; Cohen *et al.*, 1997). Thus a revised IPM strategy for tropical rice, based on these studies, advocates a shift in priority from host-plant resistance to naturally occuring biological control, while minimizing insecticide inputs, for sustainable and durable rice production systems.

Meanwhile, the global market share of pesticides sold in Asia has increased. For example, in 1988, worldwide sales of rice pesticides reached US$2.4 billion, sufficient to nudge out maize and cotton as the single most important crop for pesticides, with 90% of this market located in Asia (Woodburn, 1990). Insecticides accounted for the largest fraction of the total market (40–50%) until 1992, after which herbicide sales exceeded insecticide sales (MacKenzie, 1996). In 1995, herbicides accounted for 39% of the rice pesticide market, followed by insecticides and fungicides at 34% and 27% respectively. Country-by-country comparisons show that Japan leads all other countries in pesticide sales of approximately 50% of the world's total.

Past and ongoing research indicates that most insect pests of tropical rice are controlled by the activity of not just a few natural enemies but a whole array, through a complex and rich food web of generalist and specialist predators and parasites/parasitoids that live above and below the water surface (Heckman, 1979; Heong *et al.*, 1991, 1992; Schoenly *et al.*, 1996a,b; Settle *et al.*, 1996). Farmer interventions impact target and non-target species in different ways because biocontrol mechanisms span multiple trophic levels and act along spatiotemporal gradients. Determining the biocontrol potential of different components of this rich biodiversity (e.g. spiders, beetles, parasitoids, aquatic predators) and their role as stabilizing and buffering agents in rice production systems still remains to be shown through future research.

In this chapter, we highlight and review community-level approaches that have helped ecologists and entomologists to understand better how insecticides affect pest and natural enemy populations in tropical rice ecosystems. We begin with a review of farmer spraying practices and insecticide use patterns and conclude that, in many instances, farmers spray unnecessarily. In the second part of this report, we limit our review of studies to those directed at the community level of biological organization because farmers normally care about the net effect