Commercial adoption of pheromones as a component in ICM of rice in Bangladesh

R8026

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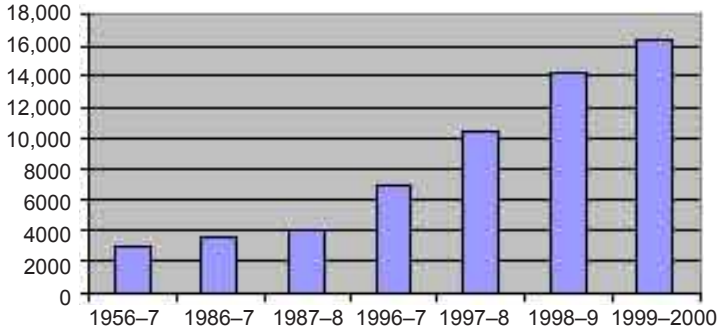
Bangladesh has been enormously successful in increasing its rice production in an effort to attain self-sufficiency. This has been largely achieved through an increase in acreage of the Boro crop (high-yielding, irrigated, post-rainy-season rice), with the BRRI introducing a range of high-yielding varieties to replace the more traditional deep-water varieties. However, insecticide use is also increasing, at the expense of both farmers and the environment. To assist local institutions and companies to work with farmers to reduce insecticide use and promote integrated crop management (ICM), this project aimed to adapt existing pheromone-based control methods (specifically for rice yellow stem borer) to local conditions, and incorporate them into the ICM programme promoted by Syngenta Bangladesh Ltd through its farmer field school programme

ISSUES

There is significant evidence that insecticide use in Bangladesh is increasing dramatically (see below). While application on rice is still significantly less than in other countries in the region, farmers perceive rice stem borers as a significant threat to their crops, and are applying pesticides where they are not actually necessary, at high cost to themselves and the environment. Because the stem borer larva is actually inside the stem of the rice it is well protected from pesticides, so farmers have to use relatively toxic systemic granular pesticides to control the pest. These pesticides are becoming redundant because of the development of resistance to them and, more importantly, because governments are becoming aware of the negative environmental and health aspects associated with the use of these compounds, so there is a now an urgent need for the development of alternative control technologies. There is growing awareness of the social and environmental costs of using pesticides such as organochlorines in Bangladesh, where agribusiness companies, such as Syngenta in particular, are keen to encourage and promote sustainable production through the development of new crop protection technologies.

Mass trapping of stem borers is a simple technology in which male stem borer moths are caught in traps baited with the female pheromone. Pheromones are naturally occurring compounds produced by insects that act as messages to other insects. Adult female yellow stem borers (*Scirpophaga incertulas*) attract their mates with a pheromone



Pesticide consumption in Bangladesh shows a 235% increase over 1996 levels

SELECTED PUBLICATIONS

CORK, A., KAMAL, N.Q., ALAM, S.N., SAHA CHOUDHURY, J.C. and TALEKAR, N.S. (2003) Pheromones and their applications to insect pest control. *Bangladesh Journal of Entomology* 13: 1–13.

CORK, A., ILES, M.J., KAMAL, N.Q., CHOUDHURY, J.C.S., RAHMAN, M. and ISLAM, M. (2005) An old pest, a new solution: commercialising rice stem borer pheromones in Bangladesh. *Outlook in Agriculture* 34, 181–187.

WREN MEDIA (2003) Pheromones – the trappings of sustainable pest control? *New Agriculturist Online*, 7 July 2003. www.new-agri.co.uk/03-4/develop/dev03.html

and this can be exploited in a pest management strategy by developing a synthetic pheromone blend and a lure and trapping system, which attract and trap male moths. If female yellow stem borers cannot mate then the pest population can be checked. Building on work conducted by scientists in India, Syngenta has been collaborating with BRRI and NRI to adapt mass-trapping technology for use in Bangladesh.

White head damage (left) caused by larvae of the yellow stem borer (below, adult)

ACHIEVEMENTS

A wide range of trap designs, pheromone blends and concentrations were tested with farmers in their fields in Comilla and Mymensingh districts in 2001–03, alongside a socio-economic study of farmers' resources, constraints and perceptions to ensure the resulting technology was appropriate for adoption.

A robust, cost-effective and efficient trapping system for male yellow stem borers was developed, using an optimised female sex pheromone lure and trap design. A series of trials designed to optimise trap design, pheromone dispensers and pheromone blends resulted in the identification of a trapping system that was effective, relatively inexpensive and easy to use. A plastic sleeve trap was found to be more effective than other trap types at higher levels of catch, and was unaffected by the weather.

On-farm, large-scale mass trapping trials demonstrated that 20 traps per hectare were sufficient to reduce male yellow stem borer populations significantly. The trials provided good evidence that mass trapping could significantly reduce the level of mating, with consequent reductions in larval progeny.

Nevertheless, the level of control achieved by mass trapping in these trials did not have a measurable impact on yield. This was due to the low level of stem borer damage observed in both treated and untreated plots, and because of the presence of other stem borer species.

The research confirmed that, despite low levels of *S. incertulas* infestation being recorded in all seasons, other species did not increase to fill the niche. The reasons for the low infestation levels are not known, but broadly reflect those found in a previous CPP project (R7296) in which, over the course of four seasons, rice stem borer infestations did not exceed the economic threshold at any site.

Extensive sampling between and within seasons demonstrated that

Optimisation of pheromone trap design*

Trap design	Pheromone dose (µg)	Mean catch per trap per night†	SE
Delta	1000	0.41	± 0.16 ab
Sleeve	1000	0.72	± 0.17 ab
Sticky plate	1000	0.85	± 0.28 ab
Open-delta	1000	1.15	± 0.29 b
Plastic cylinder	1000	0.47	± 0.11 ab
Plastic pot	1000	0.22	± 0.07 a

*Doulatpur, Laksam, Comilla District, T. Aman 2001, four replicates, 42 nights.
†Means followed by the same letter in a group are not significantly different $P < 0.05$ by Newman–Keuls multiple range test on $\log(x + 1)$ transformed data.

rice stem borers in Bangladesh constitute a species complex of *S. incertulas*, *Sesamia inferens* and *Chilo polychrysus*. The relative abundance of each species varied markedly within and between seasons, with *S. incertulas* appearing early in the season, often to be replaced by *S. inferens*.

Despite the high intensity of rice cultivation, yellow stem borer was found to be of economic importance only in the Aman season. Based on project results, stem borer control is not recommended in Aus and Boro season crops.

The project contributed significantly to the understanding of how mass trapping can be developed and implemented as a method of controlling field crop pests. The new knowledge has already been utilised in a related DFID Competitive Research Facility project for control of brinjal shoot and fruit borer, *Leucinodes orbonalis*, in India and Bangladesh (R7465C), and will have significant value for other target pest species.

Farmers' perceptions of damage, however, are not necessarily in accordance with the scientific evidence. The key issue for insect pest management in rice in Bangladesh is how to encourage farmers to target their interventions against stem borers more efficiently and in an environmentally friendly way. The socio-economists conducted a very useful study that will help to guide the strategy for promotion of the pheromone technology. Critical considerations such as product pricing and training and information provision were addressed in depth and suitable recommendations were made.

Despite information gathered on the low levels of stem borer infestation, in surveys carried out by this project, over 90% of farmers identified yellow stem borer as the major pest of rice, with 58% of respondents citing damage levels in excess of 10%. Farmers had a good knowledge of the effect of stem borer larvae on rice, but did not distinguish between species. Many farmers are not aware that the yellow 'worm' inside the rice stem that they recognise as a pest will mature into a moth, but they do know that if they do not control it the rice grains that form will be empty (white heads) and have no nutritive value.

Unfortunately, although women were involved in post-harvest and household activities they were unwilling to be interviewed by male researchers, and gender issues will need to be addressed in any subsequent work.

Pesticide dealers were considered by farmers to be a main source of knowledge on pest control, although 65% indicated that they chose an insecticide based on brand name. Despite the apparent importance of stem borers, farmers spent only 2–5% of their crop production costs on insecticides – although this was significantly higher than for other pests, apart from weeds. Over 60% of farmers interviewed had received IPM training, and over

The water trap (used here in brinjal) being tested for effectiveness in the field

80% believed it was effective, but few practised it. Pesticides were generally considered to be effective and, although most farmers were aware of side effects, over 80% of farmers surveyed used them to control stem borers.

Farmers involved in the trials were unclear about the effectiveness of pheromone traps, in part because of low infestation levels. To test their interest in the technology, farmers were offered a chance to purchase traps. Seven farmers bought 27 traps between them and, on seeing the moths they caught and the low infestation levels in their fields, were generally pleased with the technology. They suggested they would purchase them again and motivate neighbours to use them, but price was an important criterion in their choice of stem borer control technology.

Efforts were made to ascertain the costs to smallholder farmers of rice production and to determine whether mass trapping would be cost-competitive with current insecticide-based control practices. The cost of rice cultivation was typically US$255–288 per ha per season, with insecticide use accounting for 2–5% of these costs. The mass trapping technology requires 20 traps per ha with two lures per trap to cover the period when the crop is at risk from yellow stem borer. The sleeve trap adopted for use in mass trapping was estimated to cost a maximum of US$21 per ha per season, or 7–8% of crop production costs. This suggests that mass trapping is more expensive than currently used levels of insecticide. However, the averaged insecticide cost disguises the fact that some farmers do not apply insecticide at all (approximately 20% of those surveyed), so those who do will actually spend more than the averaged value. In addition, pheromone traps can be used for a number of seasons and farmers are unlikely to adopt the density

The plastic sleeve trap was more effective at higher levels of catch and was unaffected by the weather

used in trials. The traps used in the trials are being imported from India, but could easily be made locally when demand develops (see page 171).

Prior to the project, the Government of Bangladesh had no legislation governing the registration and use of biopesticides and related biorational pest control technologies, even though IPM is widely promoted as the method of choice for agricultural pest control. NRI provided technical assistance to Syngenta and BRRI in their efforts to clarify the position with the Pesticide Technical Advisory Committee. Following intensive lobbying by Syngenta, BRRI and the Bangladesh Agricultural Research Institute (BARI), the Committee accepted that pheromones were a special case and has allowed Syngenta to submit documentation for registration of pheromone products, Giant and Gem, for control of brinjal shoot and fruit borers, and fruit fly, respectively.

This activity has resulted in policy change and increased the profile of biopesticides within Bangladesh to the extent that other biopesticides are now actively being considered for pest control, notably nuclear polyhedrosis virus and neem products.

Pheromone trap-catch data suggest that traps can be used to predict the emergence of adult moths and hence the likely timing of mass trapping or other remedial actions to control progeny. Syngenta will promote pheromone traps in the first instance for monitoring and, depending on farmer interest, will introduce mass trapping in selected areas as part of its IPM Farmer Field School Programme (see page 163).

FURTHER APPLICATION

Syngenta is now committed to implementing the pheromone technology and incorporating it as a component in its Farmer Field School Programme.

Given the technical advances made as a result of the project and the greater understanding of farmers' perceptions, the next step is to move towards actively assisting Syngenta to market pheromones and developing and implementing technical training packages in IPM for pesticide dealers, NGOs and extension workers for both rice and vegetables (see R8367, page 169).

This project has successfully brought together a private-sector organisation and the government-funded rice research institute, and has developed links with the Department of Agricultural Extension. Thus a strong alliance is in place for sustainable implementation of the outputs. By identifying the central role of pesticide dealers in the provision of pest management advice, as well as products, to rice farmers the project has helped to target delivery mechanisms more precisely.

Promoting farmer adoption and policy change for rice and vegetable pest pheromones in Bangladesh

R8367

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The aim of this project was to develop and promote pheromone technologies for control of major crop pests in Bangladesh, including brinjal shoot and fruit borer and rice stem borers. Training and marketing materials were developed for pesticide dealers and for rice and brinjal farmers on the use of pheromone traps and related IPM technologies. The project worked with Syngenta and its dealer network in order to build capacity and facilitate understanding of the nature of pheromones and their potential for pest control, and through lobbying to enable the registration for sale of these affordable and sustainable products.

ISSUES

Various CPP projects have produced and refined simple, practical, pheromone-based technologies to help control crop pests and reduce the over-use of high levels of pesticide. These include a pheromone-based mass trapping system for male yellow stem borer (*Scirpophaga incertulas*) in rice (R8026, see page 165), and a related CPP project for control of brinjal shoot and fruit borer (*Leucinodes orbonalis*) in India and Bangladesh (R7465). While these practical technologies are

Brinjal (eggplant or aubergine)

affordable and easy to use, their uptake is limited for a variety of reasons, including limits on local production (R8304, page 171) and the lack of an infrastructure for the registration of relatively new biotechnology products (see page 168). Following intensive lobbying by Syngenta, BRRI and BARI (see page 168), Bangladesh's Pesticide Technical Advisory Committee has for the first time allowed Syngenta to submit documentation for registration of two pheromone products: Giant, for control of brinjal shoot and fruit borer; and Gem, for control of the fruit fly *Bactrocera cucurbitae*.

ACHIEVEMENTS

The ultimate aim was to create a platform in Bangladesh to promote pheromone products to a receptive farmer population and to enable sustainable transfer of the technology into the market. A key advantage of this approach was the ability to draw on the considerable influence wielded by pesticide dealers and a major agribusiness company, Syngenta, to promote products to farmers. Syngenta has a reputation for high-quality products in Bangladesh and commands considerable brand loyalty. With a network of 12,000 pesticide dealerships, the prospects for achieving sustainable impact at the farmer level augured well, provided the products were marketed with the correct approach and the price compared well with alternatives. While the potential to provide Syngenta with a significant financial advantage was recognised, it is anticipated that other agrochemical companies will enter the market place in time, ensuring that prices to the farming community are competitive.

Farmers' views of pheromone technology were sought, and strategies were developed for overcoming risk aversion to new technologies among farmers. Farmer demonstration trials and

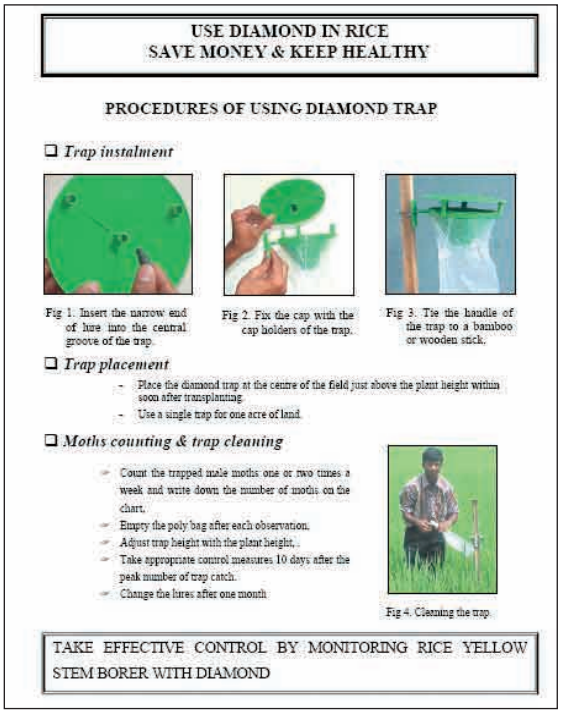
SELECTED PUBLICATIONS

CORK, A. (2005) Technology and application of semiochemicals in pest control: problems and perspectives. Presented at the International Symposium on Herbal Medicine, Phytopharmaceutials and other Natural Products: Trends and Advances, 15–17 June 2005, Colombo, Sri Lanka.

CORK, A., ALAM, S.N., RAHMAN, M., KAMAL, N.Q. and TALEKAR, N.S. (2004) Mass trapping for control of rice and vegetable pests in South Asia. In: *Proceedings of the XXII International Congress of Entomology*, 15–21 August 2004, Brisbane, Australia (abstract).

CORK, A., ALAM, S.N. and TALEKAR, N.S. (2005) Development and commercialization of mass trapping for control of brinjal borer, *Leucinodes orbonalis* in South Asia. pp. 29–33. In: *Proceedings of National Symposium on Recent Advances in Integrated Management of Brinjal Shoot and Fruit Borer*, 3–4 October 2005. Indian Institute of Vegetable Research, Varanasi, India.

CORK, A., ALAM, S.N., ROUF, F.M.A. and TALEKAR, N.S. (2005) Development of mass trapping technique for control of brinjal shoot and fruit borer, *Leucinodes orbonalis*. *Bulletin of Entomological Research* 95: 1–8.



Selections from flyers for pheromone-based products available in Bangladesh – Giant trap for brinjal shoot and fruit borer, and Diamond traps for yellow stem borer

stakeholder meetings to assess their responses to the new products received positive feedback. However, problems with one batch of commercially produced lures highlighted the need for effective quality assurance of products before release to farmers.

Baseline socio-economic data were obtained on farmers and pesticide dealers involved in the control of rice and brinjal pests at three locations in Bangladesh. Pesticide dealers were positive about the new technologies for control of brinjal borer although, in common with farmers, they needed reassurance that the technologies were effective and would provide an acceptable economic return. Dealers indicated they received a 10% profit margin on pesticides.

Farmer surveys provided evidence for the positive impact of farmer training sessions on the use of rice and brinjal pheromone products, although many farmers felt the need for additional technical assistance. Syngenta aims to accommodate this by focusing promotional efforts on particular areas or whole villages.

Syngenta's marketing strategy for rice and brinjal pheromone products has been enhanced by the information gathered, and promotional materials for farmers, pesticide dealers and Syngenta personnel have been published in the form of flyers (printed in Bengali and English), and a multi-media presentation that describes the problems associated with insecticide use, the function of pheromone traps and how they can be incorporated into IPM strategies for rice cultivation.

Of the vegetable-production land in Bangladesh, 19% is used for cultivating brinjal, which represents 41% by weight of the vegetables produced. Replacement of insecticides for control of the major economically damaging insect pest *L. orbonalis* with a benign control technology (Giant), which has a cost–benefit ratio of at least 1 to 1.8, will contribute significantly to reducing the impact of key pests and diseases, improving yields and reducing pesticide hazards.

Legislation to enable biopesticides, including pheromones, to be registered for use in Bangladesh has now been accepted by the Pesticide Technical Advisory Committee, but not yet gazetted into law by the end of the project.

FURTHER APPLICATION

By late 2005 the registration process had been gazetted into law and negotiations to secure a supply of active compounds in the region are well advanced. Syngenta is now at an advanced stage of developing additional semiochemical-based products to extend the range of production systems affected. It is anticipated that, should the process be successful, Syngenta may well adopt a similar approach in other regions where these or related insect pests are economically important.

Nevertheless, technical gaps remain, such as the need for knowledge on the relationship between rice stem borer damage and pheromone trap catch to enable Syngenta to provide farmers with an action threshold. Data on the proportion of an available adult pest population that can be trapped with current technologies would provide a better insight into how these trapping systems can be optimised further.