Bio-intensive pest management reduces pesticide use in India

In Kothapalli village, Andhra Pradesh, insect pests are the prime constraint on crop yields. Complete dependence on chemical control for the past three decades has led to unsatisfactory pest management, followed by diminishing profits. In 2000, bio-intensive pest management technologies were adopted to alleviate the pest problems in major crops like cotton, pigeonpea, chickpea and vegetables. Through improved pest management farmers have increased yields and decreased expenditure on pesticides. ***GV Ranga Rao, OP Rupela, SP Wani1, SJ Rahman****,* ***JS Jyothsna****,* ***V. Rameshwar Rao*** *and* ***P Humayun*** *report.*

Adarsha watershed and Kothapalli village are in the Ranga Reddy District of Andhra Pradesh, India, 50 km northwest of Hyderabad. The total area under cultivation is about 430 hectares (ha) and farmers grow several crops including cotton (120 ha), maize (150 ha), sorghum (55 ha), pigeonpea intercropped with maize (100 ha), chickpea (60 ha), vegetables (60 ha), and paddy (60 ha). Over the past three decades indiscriminate pesticide use has resulted in the build up of resistance to insecticides[1], harmful residues in food products[2], resurgence of secondary pests[3], and increases in pesticide use. Farmers in the village were spending about US$50,000 annually on purchasing insecticides against total production costs of about US$125,000.

In 2000, an integrated watershed management programme was initiated by the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) funded by the Asian Development Bank and the Government of Andhra Pradesh. The project adopted bio-intensive pest management (BIPM) techniques and worked to develop eco-friendly alternatives to chemicals. One of their challenges was to counter the cotton bollworm *Helicoverpa armigera*, a key insect pest on several crops.

BIPM techniques

Studies in the village adopted a farmer participatory integrated watershed management approach. Farmers used a range of techniques including planting seeds of high-yielding tolerant varieties, use of biopesticides (insect pathogens such as nuclear polyhedrosis virus (NPV), bacteria and fungi), pheromones, and an indigenous technique which was manual shaking of pigeonpea to combat *Helicoverpa.*

Shaking pigeonpea to remove pests Photo: Suhas Wanil

Pigeonpea and chickpea

Pigeonpea and chickpea crops were examined during 2000-2002. Five farmers adopted the BIPM techniques and their results were compared with the adjacent five farmers fields where chemicals were applied (non-IPM). During 2000-01, pigeonpea BIPM farmers applied one spray each of neem fruit extract and Helicoverpa NPV (HNPV) followed by manual shaking (three to five times). They did not apply any chemicals. Non-IPM farmers sprayed three to four times with chemicals including endosulfan, monocrotophos and cypermethrin. During 2001-02 season, BIPM farmers used one spray each of neem and HNPV followed by manual shaking (two to four times) of pigeonpea, while non-IPM farmers used two to three rounds of chemical sprays.

In chickpea, after the rainy season 2000-01 the BIPM plots received one to three sprays of HNPV while the non-IPM farmers did not apply any plant protection products. During 2001-02, BIPM farmers applied one spray of neem fruit extract and two sprays of HNPV, while non-IPM farmers used two sprays of synthetic pesticides.

Cotton

Cotton farmers initiated BIPM practices during 2003-04 and continued until 2006. The BIPM protocol was followed and evaluated by 17 farmers during 2003-04, nine farmers during 2004-05 and five farmers during 2005-06. Each farmer divided a given field into two halves, one for BIPM and the other for 'farmer practice' (FP/non-IPM). The BIPM farmers used five different preparations; two botanicals, neem (*Azadirachta indica*) and *Gliricidia sepium* (a leguminous tree), prepared using vermicomposting, a biological method; the bacterium *Bacillus subtilis* strain BCB19 mixed with the fungus *Metarrhizium anisopliae* (a research product of ICRISAT). The last two components are traditionally used by farmers; a cow urine solution and a mix of curd, jaggery (concentrated sugarcane juice) and bread yeast. The cow urine is believed to serve as a repellant and the second mixture as an attractant to friendly insects, such as wasps. The curd recipe was applied only once at about 50% flowering. In addition, a mixture of three different bacterial strains (a) *Pseudomonas fluorescens* (promotes plant growth, makes phosphorus more available to growing plants and suppresses soil-borne fungi) (b) *Azotobacter vinelandii* strain HT54 (a nitrogen-fixing bacterium) (c) *Bacillus lichenriformis* (promotes plant growth), were applied to the soil at sowing.

Results

Pigeonpea

Most *Helicoverpa* eggs and larvae were detected on pigeonpea during the first two weeks of November. The larval population in BIPM plots was always lower than in non-IPM plots. IPM interventions substantially decreased borer damage to pods and seeds. In 2000-2001 BIPM plots had 34% pod damage compared to 61% in non-IPM plots. The seed damage was also lower in BIPM plots (21%) compared to non-IPM plots (39%). This lower pod borer damage in BIPM plots was reflected in a higher yield of 0.77 tonnes/ha (45% more) compared to 0.53 tonnes/ha in farmer practice.

In 2001-2002 the BIPM interventions resulted in 33% and 55% reduction in pod and seed damage respectively. The BIPM plots yielded 0.55 tonnes/ha (140% more) compared to 0.23 tonnes/ha in non-IPM plots even though the overall yields were low.

Chickpea

During 2000-01 eggs and larvae first appeared on chickpea plants during the first two weeks of November when the crop was around 30 days old. Numbers of larvae continued to increase until the first two weeks of December at the podding stage. Fewer larvae

Vermicompost washes from composted neem kills young Helicoverpa larvae Photo: Suhas Wanil were present in the BIPM fields throughout the vulnerable phase of the crop. The BIPM farmers had three times higher yields of 0.78 tonnes/ha compared to 0.25 tonnes/ha in non-IPM fields (over 300% increase in yield). This was primarily due to more effective pest management and use of an improved variety (ICCV 37) developed at ICRISAT.

During the 2001-02, the larval population at vegetative and flowering stages was more in non-IPM plots. There was a small reduction in pod damage (4%) and 19% increase in grain yield in BIPM plots compared to non-IPM plots.

Cotton

During 2003-04, the BIPM fields on average yielded 30% more than non-IPM fields and a majority of BIPM farmers harvested higher yields. In addition, every farmer adopting BIPM saved money. BIPM cost Rs 1,000 per ha compared to conventional farmer practice at Rs 4,800 per ha (US$106 per ha).

After realizing good results from BIPM in cotton, six farmers from this village adopted the same technology to protect tomatoes. During 2005, BIPM farmers realized 2-322% yield gain compared with conventionally managed plots. The productivity of tomatoes varied from 1.68–7.93 tonnes/ha in BIPM compared to 1.31–5.34 tonnes/ha from non-IPM fields. The difference in productivity varied with the level of inputs used by various farmers. For example, the farmer who invested least (only Rs 561 per ha) on bio-intensive plant protection and had a much lower yield (1.68 tonnes/ha) compared to another farmer who invested Rs 2,870 per ha and harvested 5.53 tonnes/ha of tomatoes. The average biopesticide investment over the six farmers was around Rs 2,057 per ha compared to Rs 2,637 per ha expenditure on pesticides in conventional farmer practice. So not only were yields increased by BIPM practices but costs were reduced.

The BIPM plots had greater populations of coccinelids and spiders, beneficial insects indicative of healthier fields. Crops in BIPM generally remained productive about three weeks longer than in the FP plots.

Reduced pesticide use

Before initiation of BIPM the farmers were investing about US$ 50,000 on synthetic pesticides. Adoption of BIPM in the village led to 50% reduction in pesticide use by 2005.

Village bio-pesticide production

At the start of the project good quality biopesticides were scarce, and this was a major constraint to the adoption of IPM techniques. And so, the project aimed to train villagers to establish their own production units in the village itself. Two women received two days training at ICRISAT in how to prepare a wash from vermicompost of neem and Gliricida leaves. They established a facility for producing the vermicompost washes in the village. During the 2004-05 cropping season, besides using the washes on their own crops, they sold the remaining compost wash to neighbours.

A village level HNPV production unit was established to cater to the needs of farmers. Six farmers and one extension worker from this village were trained on HNPV production, storage, and usage. The villagers quickly adopted the technology and produced 2000 larval equivalents of virus during 2000-01, enough product to treat 10 ha of cotton, pigeonpea and chickpea and obtained satisfactory control. The farmers of Kothapalli village continued the HNPV production after this period as an important component of IPM on several crops. However in recent years ICRISAT in collaboration with national agricultural research systems (NARS) and NGOs established another 76 village level HNPV units to further strengthen IPM in India. This approach created awareness among farmers about the role of eco-friendly options and of sustainable ways to produce quality products.

Comparison with other studies

Earlier studies demonstrated that neem and HNPV were as effective or more effective than synthetic pesticides or other biopesticides in reducing larval population and pod damage by *Helicoverpa* in chickpea[5,6]. Studies in cotton showed that neem-based products were on a par with synthetic chemicals in reducing pest population and boll damage[7].

Most of the farmers involved in this study realized significant savings in their plant protection inputs without sacrificing yields. Earlier experiments also demonstrated the superiority of IPM strategy in terms of both pest control and cost/benefit ratio over conventional farmer practice[8,9]. The two-year experience in legume crops and three-year experience in cotton strongly suggested that BIPM can successfully be followed in the management of insect pests in chickpea, pigeonpea, cotton and tomato. Other studies have indiciated that biopesticides based upon entomopathogenic bacteria, fungi and viruses can play an important role in the management of cotton bollworm/legume pod borer[10].

Conclusions and future

Understanding the impact of eco-friendly approaches on health and the environment would require detailed analyses of the impacts of various synthetic pesticides.

Realizing the bottlenecks in bio-pesticide availability at farm level, effective production technologies were developed at village level. This not only addresses the availability, economics and timeliness, but also generates employment opportunities for rural people. Though BIPM proved effective in the management of insect pests, rate of adoption was generally low. This was generally associated with lack of understanding, availability of BIPM options, dependence on chemical pesticides as a habit, inability to distinguish between pests and beneficial insects, and lack of appreciation of the biological approach to crop protection. However, the fact that the protocol could be shared and executed successfully by farmers through guidance from field level technical staff, suggests there is scope to scale it up. ICRISAT is taking the BIPM concept further through watershed development projects and ICM projects in Asia and Africa. These days one can see considerable change in consumer preference for healthy foods which is the outcome of several IPM projects supported by government and NGO's.

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