Alternative pest control approaches: NPV for pod borer control and its uptake in Nepal

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Abstract

Pod borer is the most serious pest of chickpea in Nepal and its control based upon chemical insecticides alone has met major problems of resistance. There is a clear need for alternative pod borer control techniques. One of the most promising alternative controls is nucleopolyhedrovirus or NPV. This is effective, safe and has been adopted in a number of countries as part of the national pod borer IPM strategy. The chickpea IPM project has conducted evaluations of NPV in Nepal and results show it to be as effective or better than existing chemical control. However, if promotion of NPV in Nepal for pod borer control were to be adopted, a policy for the supply of NPV would need to be developed. Importation is feasible but local production would probably be cheaper. Several models of local production exist including farmer production, village production, state or extension service production and commercial private sector production and these models need to be evaluated for adoption in Nepal. A national system of regulation for NPV would also need to be developed.

Introduction

The pod borer *Helicoverpa* (Heliothis) *armigera* has been shown to be the most serious pest of chickpea in Nepal (Pathic 2001) and is the major pest of legumes, cotton and vegetables in much of South Asia (Reed et al. 1987). The main tool for control of this pest has been the use of chemical insecticides. However, in the last two decades control with chemicals in Asia has become increasingly unreliable and expensive due to the development of resistance to many chemical insecticides (Armes et al. 1992). It is true that new chemical insecticides, "new chemistries," are appearing that should overcome the resistance problem

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encountered by older chemical groups such as organophosphates, carbamates and pyrethroids. However, these will be much more expensive than the older chemicals and so may be difficult for poor farmers to afford. In addition, there is no evidence that pod borer will not in due course develop resistance to these new chemicals as it did to the older molecules.

There is therefore, an increased interest in and use of alternative biologically based control technologies, either as a replacement for chemical control or as a component for incorporation into an insect resistance management strategy. Most prominent among these options for pod borer is the natural pathogen nucleopolyhedrovirus (NPV) as a biological or biopesticide.

Issues for NPV adoption in Nepal

Nucleopolyhedrovirus (previously known as nuclear polyhedrosis virus) is a member of a naturally occurring family of viruses, the Baculoviruses, which cause diseases of insects and some other arthropods. About 600 species of these viruses have been identified to date (Hunter-Fuijita et al. 1998). NPV are specific insect viruses causing lethal infections in one or more closely related host species. The NPVs have been studied now for over 50 years and all safety reviews have confirmed that they are restricted to their invertebrate hosts and are completely safe for man, domestic animals and plants (OECD 2002). These viruses have been shown to have no effect on beneficial predatory or parasitic insects and are thus compatible with all biologically based IPM approaches that seek to preserve or enhance the natural enemies of crop pests.

NPVs as plant protection agents have been developed into a number of biological pesticides mainly against Lepidoptera in USA, Europe and Asia (Copping 2001). This group includes viruses of key lepidopteran pests such as *Helicoverpa* spp. and *Spodoptera* spp. many of which have become highly resistant to chemical insecticides. In all these species, the respective NPV cause a specific lethal and highly infectious disease of their host insects. The limited evidence from laboratory and on-field resistance is that resistance to NPV is slower to appear than with conventional chemical pesticides, a factor making their use as crop protection agents particularly attractive with those pests such as pod borer that have shown a rapid capacity to develop resistance to new chemicals (Moscardi 1999).

NPV for pod borer has now been developed as a commercial biopesticide by a number of private companies in India (Puri et al. 1997) as well as being produced by state sector producers (Sharma 2004) and similar products have been developed in China (Entwistle 1998) and Thailand (Warburton et al. 2002). A slightly different strain, the H.zeaNPV is now very widely used in Australia for pod borer control on a range of crops (Murray Personal communications).

The *Helicoverpa armigera* NPV or HNPV has been well studied, and following its first record in India in the 1960s, extensive research work has identified it as a very promising control agent for pod borer on a range of crops in India and Nepal (Grzywacz 2001, Grzywacz et al. 2004). Field trials in India have shown that NPV can control pod borer as effectively or better than commonly used pod borer insecticides such as pyrethroids, endosulfan or *Bacillus thuringiensis kurstaki* (Rabindra et al. 1992, Cherry et al. 2000).

Given NPV's demonstrated efficacy for controlling pod borer, should we now consider promoting its adoption in Nepal and what problems and constraints will such a strategy face?

First, we have to confirm that HNPV is technically effective in controlling pod borer when used in Nepali farming systems and ideally it should be better than existing chemical insecticides in controlling pod borer. Field trials carried out in Nepal in 2003 confirmed that NPV was more effective than the standard insecticide Thiodan (Stevenson 2004) on both traditional and new high yielding varieties of chickpea (Fig. 1). These trials also tested the use of promising adjuvants that had been suggested could improve the persistence and kill with NPV. These had been tested in the laboratory with promising results. However

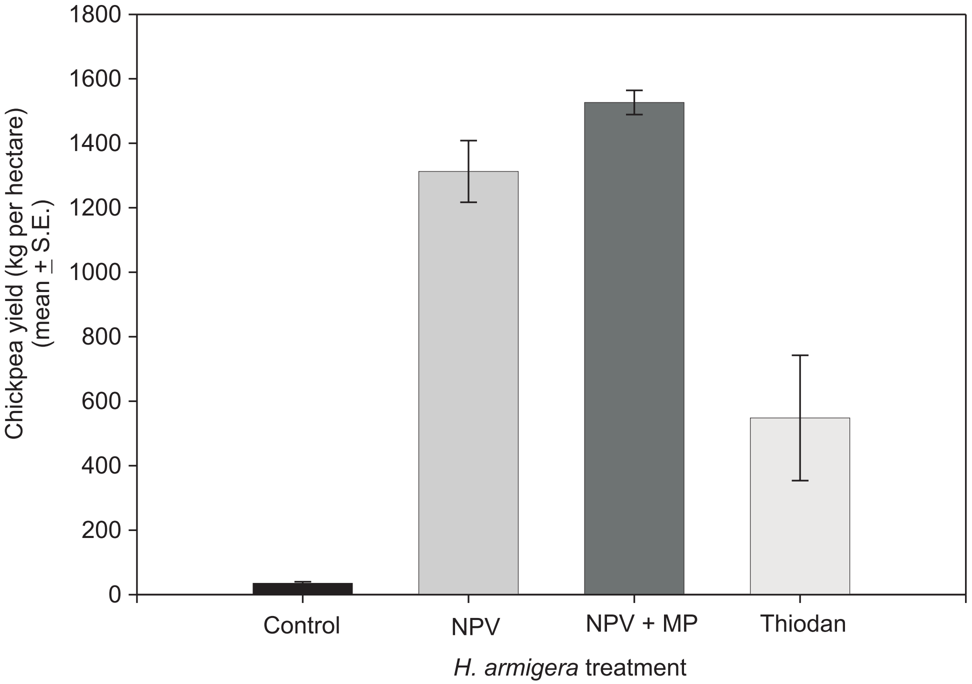

Fig. 1. Chickpea yield results from on-station trials of IPM packages with Avarodhi variety of chickpea, Rampur, 2003.

field trials in Nepal with the best of adjuvants gave results generally no better and often worse than with unformulated NPV, and so their use cannot yet be recommended as standard (Stevenson 2004).

Secondly, we must ascertain if farmers will happily adopt this technology. This will require NPV performing to farmers' satisfaction and being available at a cost acceptable to them. Trials carried out as single replicate split plot trials with farmers evaluating HNPV in Nepal were also carried out in 2003 and these also showed the NPV as good as or better than the standard insecticides (Fig. 2). These trials need to be continued to gather additional efficacy data and the results could provide data for eventual registration of NPV. Such station trials should be focused on areas where resistance to chemical insecticides is already reported as this is where the need for alternative control is most acute.

Most farmers prefer broad-spectrum insecticides because they are fast acting and can be used on a variety of crops. A specific control such as NPV is less attractive to farmers unless the broad-spectrum chemical alternatives are failing due to resistance, thus becoming unreliable and making chemical control too expensive. The use of NPV for pod borer control is being adopted by farmers in India and Thailand primarily, where chemical resistance is a

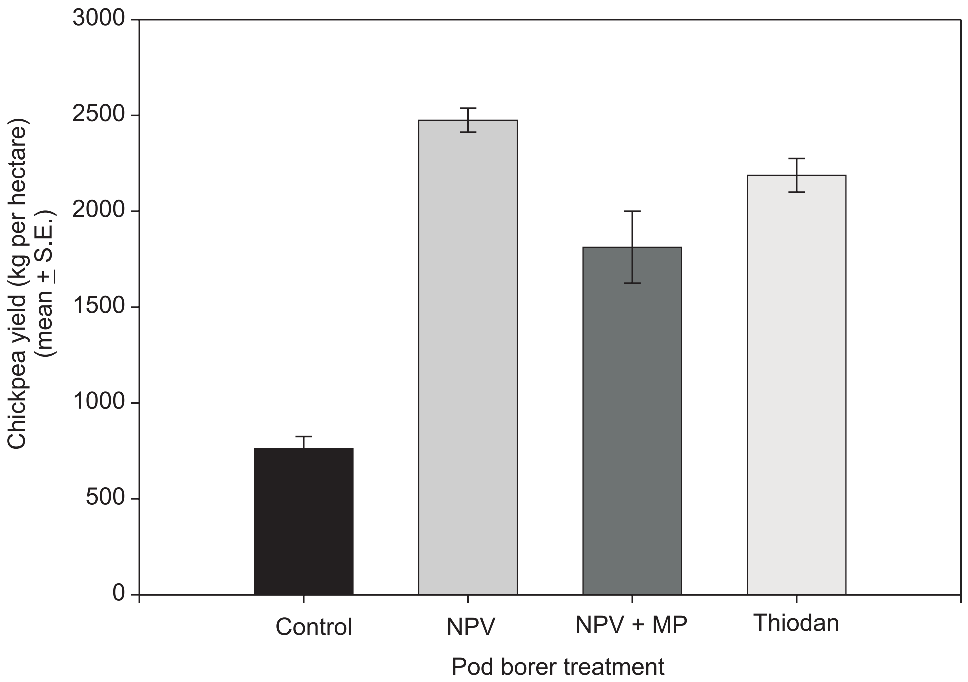

Fig. 2. Chickpea yield results from on-farm trials of IPM packages with Avarodhi variety of chickpea, Bardia, 2003.

serious problem. Reports of resistance to chemicals by pod borer causing failure of control were recorded from western Nepal in 2003 in districts adjacent to major cotton-growing areas. This pattern of insecticide resistance in pod borer often arises first in cotton growing areas and is very common in India as the overuse and misuse of insecticides on cotton is widespread and is a powerful driver of resistance in *H. armigera*.

The way forward in evaluating NPV for technical and farmer acceptance is to carry out trials initially with farmers in areas where chemical resistance is reported as a serious problem such as the Western Terai as part of on-station and on-farm trials along the lines of mother-baby trials.

A problem with getting farmers to adopt NPV insecticides is that they do not have the rapid kill associated with synthetic insecticides. As this is not observed with specific biological insecticides such as NPV, farmers find it initially disconcerting and see it as "evidence" of lack of action. The widespread kill of non-target arthropods may be perceived as an indication of an insecticide's potency. A specific biological insecticide such as NPV only produces visible evidence of corpses of target pests some days after application, typically 3-7 days when the infection cycle has been completed. It is important that farmers are educated to understand that in the meantime, NPV is not inactive but that by inducing illness, it causes a cessation of damage. Also, that by multiplying in the host NPV is capable of propagating and increasing its impact by spreading to new hosts and persisting in the system. It must be recognized that getting farmers to adopt a wait-and-see attitude to NPV and ignoring the absence of immediate impact is crucial if they are to accept its use. This in turn stresses the need for promotion of a biological insecticide such as NPV to be supported by adequate information and knowledge.

A program of NPV trials will need technical support, which should be provided by suitably trained staff from a NARC research station, extension staff or from a project NGO. On-station and on-farm trials of NPV carried out in an earlier phase of the project gave positive results and indicated that this technology can work in Nepal. To support a program for the adoption of NPV in Nepal, there will be a need to develop capacity in NPV technology. This has already begun as collaboration between ICRISAT and some NGOs but some development of research capacity with NARC would also be advisable. Training for extension workers should cover identification of pests, mode of action, quality control, bioassay protocols, field trials and production of NPV. While good training material in these techniques is available (Hunter-Fujita 1998, Grzywacz et al. 2002) adequate training with competent experts is highly desirable for such staff.

Local production and regulation of NPV in Nepal

The adequate supply and relative cost of NPV will be a significant issue in Nepal. HNPV products for the trials in Nepal were obtained from companies in India and a large number of NPV products are available from research organizations or commercially (Sharma 2004). However, this may not be the most cost effective or acceptable strategy in the long term. An alternative would be to establish production of NPV in Nepal as this would probably lower costs and increase availability.

One of the attractions of NPV is that its production is not a technically complex process like the synthesis of chemical insecticides. NPV is produced by infecting live host insects in the early larval stage, then rearing them while the infection develops. In appropriately infected larvae, the NPV multiplies within seven days producing 2000-5000 million infectious NPV particles or occlusion bodies per larvae. Homogenizing 200-500 such larvae is enough to produce a suspension of NPV sufficient to treat one hectare of crop. These larvae can be reared on either freshly collected plant material, soaked chickpeas or an artificial diet sprayed or soaked in an inoculating solution of NPV. Rearing facilities can be simple involving rearing trays or containers in which to hold larvae while the infection develops and the NPV multiplies. An example of a low cost model system is one developed by Dr GV Ranga Rao of ICRISAT where all the equipment to set up a pilot unit costs about $450. A number of other similar systems for NPV propagation in developing countries have been previously described (Hunter-Fujita et al. 1998; Moscardi 1999, Grzywacz et al. 2002).

Thus, setting up NPV production in Nepal is feasible if local demand patterns and economics make this the most attractive option. NPV could be produced by local research institutes, or NGOs might become involved in such production as happens in some areas in India. In India, state sector producers either as part of commodity boards, state governments or the central government, play a major role in the supply of biological pesticides such as NPV and fungi (Sharma 2004).

Another option for mass production is for it to be undertaken by small to medium enterprises either devoted to biological plant protection products or as an offshoot of established agro enterprises. The development of such companies has often followed the transfer of the technology from pilot producers in the state sector to local companies once the success of an NPV product has been established and a market created. This has been seen in South America, Asia and now Africa (Moscardi 1999, Warburton et al. 2002).

In India, there have also been initiatives to start farmer or community-based production of NPV (Anon 2004). The concept here is that village production is the only way to allow poorest farmers' access to the technology, as this approach reduces costs as well as simplifying the supply chain. This is an interesting system potentially attractive for supply in Nepal as it produces NPV at minimal cost where it is needed. Some start up costs and technical support from NGOs or other extension organizations are essential in the establishment phase. However, the economic sustainability of these farmer/village production models has questioned, as has product quality (Tripp and Ali 2001). So, the long-term viability of this system would need to be established before its widespread adoption was promoted.

Buying in NPV from India or producing locally may both pose significant quality problems. Early production in India was marked by uneven product quality and subsequent control failures (Kennedy et al. 1998), a problem by no means restricted to India (Warburton et al. 2002). Quality assessment of NPV is not technically complex but it does need to be carried out to internationally acceptable standards (Jenkins et al. 2000). A solution to this challenge would be to develop in Nepal expertise capable of conducting quality assessment of locally produced or imported NPV. Such a central quality laboratory could be set up in Nepal as part of a national policy of NPV building capacity.

This brings us to the need to develop suitable regulation and registration policies for Nepal to ensure NPV products are safe and effective. On safety, the evidence is that NPV is completely safe, a judgment confirmed in a recent major independent survey commissioned by the OECD (OECD 2002). However, poor quality production can result in significant bacterial contamination of NPV products and it is conceivable that highly contaminated products may pose a microbiological hazard (Grzywacz et al. 1997), though as yet no actual cases have been reported in the literature. If NPV is to be promoted, there is therefore a strong case for developing quality control (QC) mechanism in Nepal and to carry out monitoring to ensure that NPV products imported or produced in Nepal are safe. As mentioned above, during the rapid expansion of NPV production in India in the late 1990s, a number of organizations produced NPV that was substandard. While these were not unsafe, they were sometimes not reliable and could lead to a loss of confidence by users. Developing NPV QC capacity in Nepal would thus serve not only to resolve safety issues but also address this quality issue.

Any policy on regulating NPV may need to cover village or farmer production as well as commercial production and importation. The implications and requirements of a policy for biopesticides such as NPV are too many to be addressed in detail here, but reference to the models developed in other countries of Asia and Africa can illustrate the issues and possible solutions in detail (Pawar 2001, Grzywacz 2004). It should be noted that aid donors (USAID, DFID) have been very supportive of policy initiatives by developing countries that serve to overcome bottlenecks to the adoption of new and safer crop protection technologies.

Overall, there is a need to develop a favorable regulatory environment, if the development of new locally produced biopesticides is not to be discouraged. Unnecessarily expensive or over complex registration procedures if adopted will only impede the development of biopesticides, as these biopesticides are usually developed by small local organizations lacking the resources of major international chemical companies. In a number of Asian countries such as Thailand and India, local production of NPV by research institutes, extension services, farmers and communities was not subject to formal registration procedures. This stimulated the development of NPV for pod borer control and did much to facilitate its adoption by farmers, so creating a market for suppliers. A similar approach in Nepal might well be a suitable option.

Conclusions

1. NPV is a potential safe sustainable solution for pod borer control in Nepal.
2. NPV should be further promoted in trial areas for large-scale participatory evaluation by farmers.
3. Local research capacity in NPV use, quality control and production should be developed within an appropriate organization.
4. Initially imported material could be used for trials, but if acceptance is good, local production using appropriate public/NGO/private sector models of supply should be developed.
5. A regulatory policy to cover biopesticides for Nepal needs to be developed by the responsible agency.

One strategy might be to develop an NPV capacity in Nepal by training local scientists in NPV production, use, quality control and regulation. These could start by collaborating in farmer trials of NPV and if these are successful and a market for the NPV is created, they could go on to start local production. This could be done at a research center or field station by using one of the low input production systems similar to those promoted by ICRISAT. After evaluation, they would then transfer this technology to a local NGO, a community organization or local private business as judged most appropriate.

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