GYPCHEK®: PAST AND FUTURE STRATEGIES FOR USE

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The development of the gypsy moth nucleopolyhedrosis virus product Gypchek, and strategies for its use, have been largely patterned after conventional pesticide technology. Prior to Gypchek registration with the Environmental Protection Agency in 1978, several field tests involving variations in virus product, application hardware, dose rates, timing and formulation were conducted. Further tests since 1978 have been promising, but nonconclusive, and 6 years after registration, Gypchek is not in commerical production. It is clear that if this product is to be seriously considered as either an alternative or adjunct to other control tactics, it must either be formulated in such a manner as to extend or amplify its activity on foliage, or it must be genetically manipulated to enhance its virulence.

As early as 1911, Reiff speculated that gypsy moth nucleopolyhedrosis virus (NPV) could be used to control the pest and some early field studies by Glaser and Chapman (1913) demonstrated its potential. In 1978 Reiff's prophecy was partially fulfilled with the EPA santioned registration of a gypsy moth NPV product Gypchek. This product was the fruit of several years of intense interdisciplinary research that ranged from understanding viral biochemistry and mode of action to testing and modifying viral delivery systems. The registration process has been bittersweet. A product that has great potential in gypsy moth management has been brought forward, yet in 1984, six years after registration, is not in commercial production. Why? The reasons will emerge as a brief chronology of Gypchek development and use are presented here.

Forest Service research on gypsy moth NPV began at the Northeastern Forest Experiment Station's Laboratory in New Haven, Connecticut in the early 1950's. A few, very limited field experiments[1] were conducted on individual gypsy moth infested trees treated with aqueous suspensions of macerated, virus-killed gypsy moth larvae. Results of these early studies were encouraging enough to test the virus in combination with Bacillus thuringiensis (B.t.) in a series of field trials in New York State, 1961-1963 (Lewis and Connola 1966). Virus used in these tests was from field collected (Connecticut) cadavers processed according to Rollinson and Lewis (1962). Since NPV was not used alone, these tests were ostensibly undertaken more for the hope of augmenting B.t. mortality than for assessing the efficacy of NPV. Results of these field tests, though showing some NPV effectiveness, were compromised by B.t. formulation and application problems, which made the evaluation of NPV effects even more difficult. What became apparent after 3 years of this type of testing was that B.t., in the same tank mix and sprayed at the same time as NPV, was antagonistic to the NPV infection process through its own mode of action, i.e., feeding inhibition through gut paralysis. Since NPV must be ingested to cause mortality, any feeding inhibitors in its formulation clearly reduce its effectiveness.

In 1963, NPV was tested alone on a 1-acre (0.4 ha) plot of mixed oak in the White Memorial Forest, Litchfield, Connecticut (Rollinson et al. 1965). Virus used was again from Connecticut field-collected cadavers (Rollinson and Lewis 1962) and was applied by truck-mounted mist blower at a rate of 4×10^{12} polyhedral inclusion bodies (PIB) in 4 gallons (15 l) of water-sticker tank mix per acre. Although data from this test is sketchy, it is apparent that the NPV was effective in reducing gypsy moth populations in the treatment plot; 96 percent egg mass (EM) reduction. No pretreatment EM counts were given for control plots whose post-treatment EM densities were 5 fold higher than those in the treatment plot. Results of this test were instrumental in securing a Forest Service research committment toward developing gypsy moth NPV as a microbial insecticide.

From these early field tests and from a variety of laboratory studies conducted on gypsy moth NPV and other insect viruses that followed, it became clear that first, gypsy moth NPV was not one of the more virulent insect viruses and second, that it remained active for only a few days following foliar application (Yendol and Hamlen 1973, Lewis and Yendol 1981). The implications of these findings relative to the development of Gypchek have been discussed in detail elsewhere (Lewis, 1981, Podgwaite 1984) but briefly, research focused on finding the most virulent gypsy moth NPV (the Connecticut strain, to date), developing a cost effective NPV production system (Shapiro et al. 1981), and finally developing a tank mix with sunlight protective properties.

By 1972 research had progressed to the point where further field testing was appropriate. A series of aerial tests were conducted in Pennsylvania between 1973 and 1978, the eventual year of Gypchek registration (Yendol et al. 1977, Wollam et al. 1978, Lewis et al. 1979). These field experiments evaluated various combinations of (1) a variety of NPV formulations (2) high versus low dose rates (3) one versus two applications (4) a variety of stickers, sunlight protectants and feeding stimulants (5) flatfan versus motorized nozzling systems and (6) morning versus evening application; all against a range of moderate to dense gypsy moth populations.

From an evaluation of all these tests emerged the current direct suppression tactic with Gypchek, i.e., two aerial applications, 7-10

[1] F. B. Lewis, Personal Communication

days apart, each at a prescribed rate between 1.0 and 5.0 x 10^{11} PIB per acre, against second stage gypsy moth larvae within moderately dense gypsy moth populations. The tank mix should include an appropriate sunlight-screen and sticker. Under optimal conditions, expected results using this tactic are (1) 50-80 percent EM reduction (2) < 55 percent defoliation and (3) the prevention of refoliation.

Results of further field tests[2] in Connecticut in 1981, using Gypchek in 4L® as well as in Protec®, although promising, were inconclusive. However, an aerial field test in Canada in 1982, using virtually the same Gypchek-4L formulation used in Connecticut in 1981, provided 95 and 90 percent EM reduction in treated plots compared to a 55 percent reduction and a 324 percent increase in EM in control plots. Treated plots averaged 20 percent defoliation compared to 45 percent for controls (Meating et al. 1983).

It is clear that there are some problems with Gypchek itself, as well as how it has been perceived, that have retarded its commercialization and its widespread acceptance as a microbial insecticide. The first is virulence. As mentioned earlier, gypsy moth NPV is of relatively low virulence when compared to several other insect viruses, e.g., the sawfly NPVs, many of which are 100 times as virulent against their respective hosts. Secondly, again reiterating, gypsy moth NPV is rapidly inactivated on foliage, losing most of its pesticidal activity within 2-3 days after treatment. Thirdly, erratic results from year to year, often due to the factors cited above, have done little to convince the user of its efficacy. Further, though the product is pesticidal only for the gypsy moth, and ultimately environmentally desireable, commercial producers are interested in developing products that will satisfy a broad market and to date have been hesitant to commit substantive resources toward developing products that will be used against only one insect. Finally, the users generally equate the performance of Gypchek with that of chemicals -- they expect equivalent results. Of course this is rarely acheived, and should not be expected. The product is essentially alive, requires 10-14 days to kill and has a narrow target window. It is unrealistic to equate its performance with a contact insecticide! The future of this product will hinge on its promotion as an adjunct to, rather than a substitute for, other pesticidal agents.

Toward this end some probing studies on alternate uses of this virus have been conducted. Parasite-NPV combinations have shown some promise. Raimo and Reardon (1981) found that the release of NPV-contaminated Apanteles melanocelus females resulted in almost double the incidence of NPV larval mortality in treated blocks compared to controls, while percentage parasitism was virtually the same in both. Podgwaite et al. (1981) introduced gypsy moth NPV into sparse gypsy moth populations by treating egg masses. In addition to an estimated 85-90 percent NPV mortality in larva hatching from EM so-treated, there was a 20 percent incidence of polyhedrosis in 4th-6th stage larvae in the year of treatment.

There are other researchable control tactics with Gypchek. These include (1) its use in sequence with other control techniques, e.g., with B.t., parasites, pheromones, sterile male moth release, and chemicals (2) the release of NPV-infected larvae into populations free of the disease (3) the release of NPV-contaminated predacious insects, mammals and birds (4) the use of attractants to lure larvae to contaminated baits and (5) the spot inoculation of this virus early in the developmental cycle of the gypsy moth or in its preceding generation.

Gypchek is at a crossroad in its development as a microbial insecticide. It is clear that if this product is to be seriously considered as an alternative to chemicals in any control strategy that involves broadcast application, then either it must be formulated in a manner that significantly extends its activity on foliage, or the virus must be manipulated genetically to enhance its virulence or perhaps increase its host range to make it more attractive for commercial development. This can be realized through a systematic research effort in the area of formulation and application, while integrating state of the art biotechnology into fundamental research on gypsy moth NPV.

[2]Lewis and Podgwaite, Unpublished Data

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