

HARPIN

Janis Jones from EDEN Bioscience describes a new biopesticide which activates natural plant defence and growth systems

Development

Harpin is a protein produced in nature by certain bacterial plant pathogens. It was discovered by Zhong-Min Wei, PhD, and his colleagues at Cornell University (Wei *et al.*, 1992) and shown to be an acidic, heat-stable, glycine-rich, extracellular protein consisting of 403 amino acid residues (no cysteine), with a molecular weight of about 40 kilodaltons.

EDEN Bioscience has further studied the harpin protein and developed the commercial product Messenger® at its research and production facility in Bothell, WA, USA. Messenger® received approval in April 2000 from the Environmental Protection Agency (EPA) as a biochemical pesticide in Toxicity Category IV (a designation reserved for materials with the lowest hazard potential), with the EPA-minimum 4-hour restricted entry interval requirement for field workers.

Mode of action (Figure 1)

When harpin is applied to plants it activates a plant's natural growth and defence mechanisms. It binds to plant receptors, initiating a set of complex signaling pathways: activating a well-defined series of systemic acquired resistance (SAR) genes, inducing the jasmonic acid/ethylene dependent pathway and eliciting plant growth-related systems. These responses protect plants against a wide variety of pests on multiple crops, while at the same time improving growth, crop yield and quality. In field response trails on a wide variety of crops, including wheat, rice, citrus, cotton, pepper and cucurbit, Researchers at EDEN Bioscience and Cornell University have demonstrated that harpin has an ability to improve growth as evidenced by one or more of the following:

- increased photosynthesis
- increased nutrient uptake
- increased biomass
- increased root development
- increased seed germination
- earlier flowering
- improved fruit development
- earlier fruit maturation

Full response normally occurs within 3–5 days after application. Resulting effects may last for several weeks, or throughout the growing season, depending on the crop.

The National Aeronautics and Space Administration (NASA) have confirmed these growth aspects during a wheat study in a highly controlled environment.

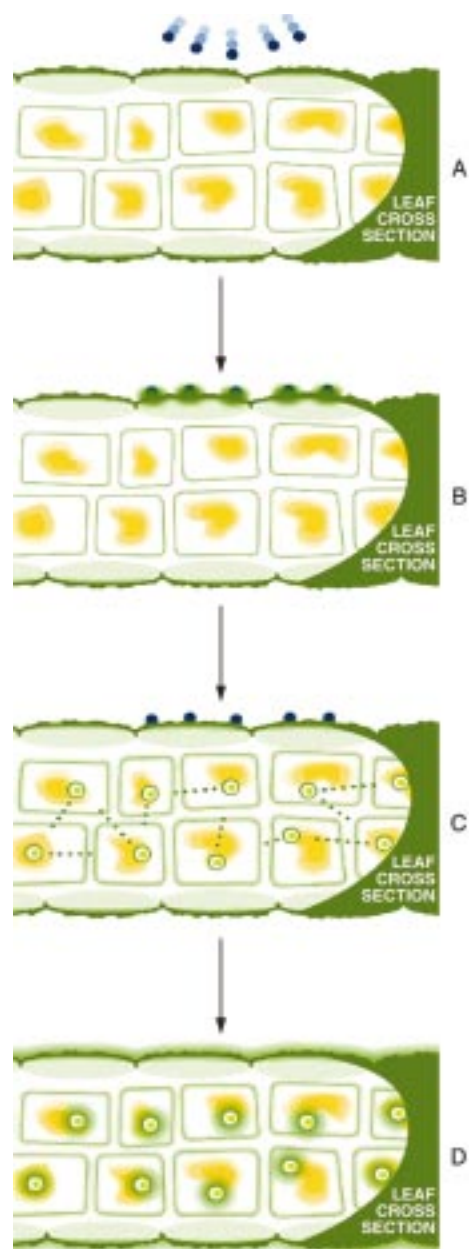


Figure 1. Messenger® mode of action.

A. Messenger is sprayed onto the plant.

B. Harpin protein, the active ingredient in Messenger®, is recognised by receptors.

C. The plant initiates and amplifies a set of complex signalling pathways, causing natural gene expression.

D. This natural process results in activation of plant defence systems, increased nutrient uptake and photosynthesis, improving crop yield and quality.

Eden BioScience receives award

Eden BioScience Corp. has received a Presidential Green Chemistry Challenge Award (Small Business Category) for its technical innovation in the development of harpin technology. These awards are given annually through the EPA Office of Pollution Prevention and Toxics to recognize organizations and individuals that are successfully researching, developing, and implementing outstanding green chemical technologies. The latter are defined as chemical products and manufacturing processes that reduce or eliminate the use or generation of hazardous substances. The award was presented at the National Academy of Sciences by Stephen L. Johnson, EPA Assistant Administrator for Prevention, Pesticides, and Toxic Substances, during the fifth National Green Chemistry and Engineering Conference. This is only the third time an agricultural product company has won the award.

Formulation

The harpin formulation Messenger® is a water-soluble, granular powder that is topically applied either independently or in conjunction with traditional chemical pesticides. Once applied, Messenger® degrades rapidly and leaves no detectable residue on plants or in the soil and degrades rapidly in the environment; there is therefore no risk of contamination of ground or surface water. In addition, harpin does not alter the plant's DNA.

Resistance

Unlike traditional chemical pesticides, harpin does not kill or otherwise adversely affect pests or pathogens, and hence it does not exert the selection pressure that promotes the development of resistance in pest populations, thus reducing the likelihood of resistance or cross-resistance development. Harpin is ideally suited to controlling pests that have developed resistance to conventional chemical treatments and to being used as a partner with highly pest-specific, lower risk products.

Crop uses

The harpin formulation Messenger® has been extensively tested in more than 1000 field trials, on more than 40 crop groupings plus turf and ornamentals throughout the world. It has been shown to be effective on a wide variety of economically important crops, such as cotton, wheat, cucumber, citrus, tobacco, strawberry, tomato and peppers. Messenger® has demonstrated effective control of viral plant diseases for which there are currently no chemical controls. Notable examples include tobacco and cucumber mosaic viruses in tomato and pepper, tobacco mosaic virus

Harpin technology for the Third World

Eden BioSciences has unveiled a program to make Messenger® available to less-developed countries. It will be made available in the first instance to small-scale farmers in Ethiopia and Kenya. Within a year, the project will be expanded to other African and Eastern European countries that apply to Eden for inclusion in the project. Representatives from Eden recently gave a half-day presentation on the Subsistence Farming Project to an audience which included some 20 ministers of agriculture from Eastern European and African nations.

in tobacco, and beet curly-top virus in peppers. Messenger®-treated tomato plants also exhibit reduced galling (root nodules), "tolerance" to root-knot nematodes, and/or increased volume and grade of marketable fruit. Additional benefits in Messenger®-treated tobacco include a "tolerance" to cyst nematodes. It has also demonstrated effective management of other soil-borne pathogens, such as *Fusarium* spp. in tomato, cucumber, strawberry and wheat.

Use in IPM programmes

Messenger®'s broad spectrum of control, ease of use and compatibility with established Integrated Pest Management (IPM) practices make it an ideal product for IPM programs. It can be used throughout the growing season as a crop production tool that induces disease resistance and insect repellence, while at the same time promoting optimal plant health. It does not disrupt the natural or introduced populations of beneficial predators and parasites that are often an integral component of IPM.

For further information on EDEN Bioscience and Messenger® see <http://www.edenbio.com>

References and further reading

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PESTICIDE BEHAVIOUR IN SOILS AND WATER

For the first time this year's *BCPC Conference – Weeds 2001* will include a special interest symposium with the above title. This will run concurrently with the main conference from 13-15 November 2001 at the Hilton Brighton Metropole Hotel, Brighton, UK. Over the 3 days platform sessions will cover sorption and mobility, degradation, quantitative aspects, risk management and environmental exposure and risk assessment. There will also be a poster programme linked to the platform sessions. For further information: BCPC Symposium Secretariat, 5 Maidstone Buildings News, Bankside, London SE1 1GN, UK. Tel: +44 (0)20 7940 5555; Fax +44 (0)20 7940 5577; email conference@bcpc.org