

## NOVEL GRAIN PROTECTION TECHNOLOGY AS A FUMIGATION ALTERNATIVE

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**Abstract** The protection of harvested crops from insect pests is crucial for maintaining the quality and quantity of stored grain. In post-harvest grain protection fumigation (phosphines) and spraying (organo-phosphates, synthetic pyrethroids) are used. Fumigants, claim efficacy against earlier stages of pests, however, early pest stages may survive treatment. Resistance against these highly dangerous gases have reached a level where control is failing to an unacceptable level. A finding corroborated by novIGRain project's working group focused on the assessment of resistance against insecticide used in Europe for stored product pests control. Today, we can no longer rely on the efficacy of existing approved formulations; there is an urgent need for alternative solutions. Larvicides have never been introduced and used in stored grain protection in the EU. Within the framework of the novIGRain project, a formulation using a larvicide active ingredient, S-methoprene is developed along with accompanying innovative technology for the protection of stored cereals. S-methoprene is a juvenile hormone analogue (JHA) biorational insecticide which act by blocking larval-pupal transformation and pupal-adult metamorphosis. S-methoprene affect insect development only at specific, susceptible developmental stages resulting in long-term population control by preventing the emergence of new insect generations. Since S-methoprene elicits a specific effect on certain insects, toxicology profile of this active substance is very favourable in non-target vertebrates. The formulation uses a renewable solvent carrier of natural origin, making the insecticide sustainable. Using grain protectant product with S-methoprene active is far less hazardous compared to the use of common adulticide. Grain protectant with 0.6 mg/kg S-methoprene applied by spraying on wheat shows 100% emergence reduction. S-methoprene can prevent the development of the red flour beetle (*Tribolium castaneum*), the lesser grain borer (*Rhyzopertha dominica*) and the saw-toothed beetle (*Oryzaephilus surinamensis*) for minimum 12 months. New ULV spraying system is developed for applying the product. Simulated use field efficacy study using the ULV spraying device with the application of a 1.2 mg/kg S-methoprene product (Methograin<sup>®</sup> IGR 30 ULV) is on-going. Introducing S-methoprene as active substance with new, versatile dual-channel ULV spraying system significantly reduces insect infestations while providing a more sustainable and safer alternative to traditional pesticide and fumigation methods.

**Key words** grain protection, larvicide, S-methoprene, novIGRain

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**noviGRain**

## INTRODUCTION

The protection of harvested crops from insect pests is crucial for maintaining the quality and quantity of stored grain.

Numerous publications [1,2] have reported the development of resistance to currently used insecticides and techniques (mainly spraying, fumigation). A finding corroborated by our project's working group focused on the assessment of resistance against insecticide used in Europe for stored product pests control. Today, we can no longer rely on the efficacy of existing approved formulations; there is an urgent need for alternative solutions, new approaches, and novel active ingredients in crop protection.

Within the framework of our project, noviGRain, we are developing a formulation containing an active ingredient 5-methoprene that has not yet been used in Europe, along with accompanying innovative technology for the protection of stored cereals. 5-methoprene is the biologically active isomer of a juvenile hormone (JH) analogue with activity against a variety of insect species including stored product pests. Juvenile hormone analogue (JHA) biorational insecticide act by blocking larval-pupal transformation and pupal-adult metamorphosis. Adult emergence inhibition occurs in the last larval, or pupal stage due to the developmental abnormalities caused by higher levels of 5-methoprene in the environment, mimicking the original JH.

The overall aim of the noviGRain project is to provide more sustainable, accessible, versatile and state-of-the-art, convenient solution for a number of end-users to gain potent, safe control of indoor post-harvested stored grain attacking insects.

## MATERIAL AND METHODS

The nine member project consortium are working in six different working groups on the implementation of the development, the creation of a "resistance map" for stored grain pests in Europe, and the socio-economic and environmental impact analysis.

Here, versatile dual-channel ULV spray system was developed for applying the novel product. The portable equipment can separately and individually be adjusted, and dose controlled to simultaneously spray two different liquid insecticides: a larvicide and an adulticide. The fully automated system ensure proper, adjustable dosing of the grain protectant.

The novel product, containing 80g/L 5-methoprene active substance is a ready-to-use, plant oil-based ULV formulation.

After preliminary human- and environmental risk assessments of the product verification of the active substance and product effectiveness has begun.

**Laboratory efficacy study [3]** was based on the modified ISO 10430 guideline PP1/204(1)

and was completed and adapted from the French method CEN 17061:

Commodity: wheat

Application rate: of 0.1 mg/kg

Replicates: 6 replicates for each test series + 6 controls

Storage: at 20°C and 60% RH, for 1, 3, 6, 9 and 12 months.

After each storage time, the residual efficacy of the 5-methoprene was assessed on red flour beetle (*Tribolium castaneum*), lesser grain borer (*Rhyssalus dominica*) and saw-toothed beetle (*Dryophila artemicola*) (stored product insects).

Adult insects were introduced on the treated and untreated grain, and 6 weeks later the number of emerged adult insects were compared between the treated and untreated batches.

**Simulated use efficacy study [4]** has begun at Bábolna site.

Emergence reduction in the naturally and artificially infested grains will be evaluated during the 1-year storage period:

Commodity: wheat

Application rate 1.2 mg/kg

Number of panels: 2 treated silos + 1 untreated control silo

Residual efficacy of the 5-methoprene will be assessed: 1, 3, 6, 7, 8, 9, 10, 11, 12 months.

## RESULTS and DISCUSSIONS

Grain protectant with 0.1 mg/kg 5-methoprene active substance applied by spraying on wheat shows 100% emergence reduction on the species introduced in the laboratory efficacy study. 5-methoprene can prevent the development of the red flour beetle (*Tribolium castaneum*), the lesser grain borer (*Rhyssalus dominica*) and the saw-toothed beetle (*Dryophila artemicola*) for minimum 12 months after treatment. None of these 3 insect species were able to reach the adult stage, unlike the untreated controls in which respectively mean 101, 1512 and 368 adults emerged.

The proper functioning of the new dual-channel ULV spraying device prototype was successfully tested under field conditions. After integrating the device with the system controlling silo filling, it accurately tracked changes in the conveyor belt speed and adjusted the application of the grain protection product accordingly, ensuring precise plant protection product dosing. The two ULV spraying nozzles performed the treatment both simultaneously and independently. Upon stopping the silo filling system, the automatic valve immediately shuts the formulation application.

As the first step of the simulated field trial, the initial infestation level was determined. The wheat stored in the silos was heavily infested with *Sitophilus oryzae*, *Sitophilus granarius*, *Dryophila artemicola*, and *Rhyssalus dominica*. The grain was homogenized through movement, and treatment was performed using the new ULV spraying device with the application of a 1.2 mg/kg 5-methoprene product (Methograin 80 ULV) in order to mimic the practical condition. The study continues according to the research plan, providing insights into the product's efficacy and changes in pest insect populations under field conditions.

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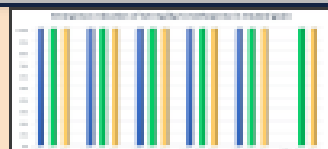


Figure 1: Laboratory efficacy study on grain protectant 5-methoprene under 100% emergence reduction of Tribolium castaneum, Rhyssalus dominica and Dryophila artemicola (stored product insects) for minimum 12 months after treatment.

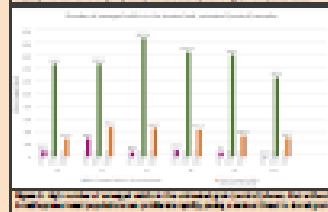


Figure 2: Simulated use efficacy study on grain protectant 5-methoprene under 100% emergence reduction of Tribolium castaneum, Rhyssalus dominica and Dryophila artemicola (stored product insects) for minimum 12 months after treatment.



## CONCLUSION

In stored grain protection most of the liquid products used are adulticides. Fumigants, claim efficacy against earlier stages of pests, however, early pest stages may survive treatment. Resistance against these highly dangerous gases (phosphines) have already reached a level whereby the earlier 100 % control, is quickly falling to an unacceptable level. In addition fumigation methods come with significant limitations, including human exposure, and environmental concerns and regulatory restrictions.

Introducing 5-methoprene as active substance with new, versatile dual-channel ULV spraying system significantly reduces insect infestations in stored products while providing a more sustainable and safer alternative to traditional pesticide and fumigation methods.

Future research and further studies on 5-methoprene will be carried out for maximizing its effectiveness and optimizing its application.

The Main Residue Level (MRL) calculations are highly feasible. The noviGRain project not only presents a new formulation and treatment method but also contributes to enhancing global food security, which is essential for maintaining an efficient food supply chain.

## LITERATURE, STUDIES

- (1) J. Szilágyi, A. Kósa-Tass, D. Bejorri, 2020. Phosphine resistance among stored product grain pests: a global overview. Insect Science, 27(2), 1-12.
- (2) J. Szilágyi, A. Kósa-Tass, D. Bejorri, 2020. The efficacy of 5-methoprene against stored product grain pests: a global overview. Insect Science, 27(2), 1-12.
- (3) J. Szilágyi, A. Kósa-Tass, D. Bejorri, 2020. The efficacy of 5-methoprene against stored product grain pests: a global overview. Insect Science, 27(2), 1-12.
- (4) J. Szilágyi, A. Kósa-Tass, D. Bejorri, 2020. The efficacy of 5-methoprene against stored product grain pests: a global overview. Insect Science, 27(2), 1-12.

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