

ZeroFly®

by VESTERGAARD



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Storage Bag Concept

An estimated 10 to 30% of worldwide annual food production is lost during postharvest processes. This not only impacts the consumer with loss of profitability but also ultimately global food security. A novel and innovative tool, an insecticide-incorporated polypropylene sack is designed to protect commodities (grains and seeds) against destructive insect pest infestation during storage.

Product description: ZeroFly® Storage Bag is a woven polypropylene bag developed for postharvest storage of commodities, including cereal grains, pulses, oilseeds and seeds. Insecticide is incorporated into the individual fibres, which provide powerful killing action against insects before they can infest the stored commodities in the bag.

Note: Deltamethrin content, unit mg/m² is only for reference. For evaluation of conforming, only unit g/kg is used

No.	Quality characteristics	Requirement	Standard method
1	Deltamethrin content (1)	3 g/kg ±25% (318 mg/m ² ±25%)	CIPAC 333, LN
2	Mass of bag	135g (-3%)	ISO 23560:2008
3	Average breaking strength of fabric	In length	ISO 23560:2008
		In width	
4	Elongation at break of fabric (length and width)	20% ±10%	ISO 23560:2008

Method of application: The active ingredient, Deltamethrin (DM), is incorporated in the polypropylene yarns woven together. The active ingredient is released on the surface of the material in a sustained manner so that the commodities stored in the bags are continuously protected against insect infestation.

Directions for use: Dry harvested or milled grains to recommended moisture levels (<14 percent for grains and <12 percent for seeds). Ensure that grain is free from insects before pouring into the bags. ZeroFly® Storage bags protect grains from a wide range of postharvest insects such as weevils, borers, beetles, moths etc. Tightly reclose bag immediately if partial amounts of grain are removed to prevent insect entry through the opening.

Residue Data

Maximum residue limits were tested utilising the accelerated shelf life test 54±2°C for 14 days* (as per FAO Pesticide Specifications/APVMA, 2005) followed by Deltamethrin extraction from the grain (CIPAC D- 333/TC/M) under standard, high moisture and high pressure environments.

Study Plan 1: The bags were subjected to a pressure of 1.5 tons and stored at 54±2°C for 14 days. Sampling was done at 30 minutes after exposure (0 day) and at the end of the 14 day storage period at 54 ± 2°C under 1.5 tons pressure.

Study Plan 2: The bags were packed with paddy grains and completely wetted with garden shower simulating artificial rain of 2 cm³ (15 min) volume. The grain samples from the bags were collected after 30 min, 24 hr. and 72 hr. after moisture exposure and analysed the residues.

Results:

TABLE 1. Deltamethrin content (mg/ kg of grain)

Day 0	Day 14
0.0174	0.0533 (0.05- 0.056)*

TABLE 2. Deltamethrin content (mg/ kg of grain)

30 min	24hrs	72 hrs
0.0135 (0.012- 0.014)*	0.0146 (0.013- 0.015)*	0.0147 (0.014- 0.015)*

TABLE 3. Maximum residue limits (MRLs) - Deltamethrin

International Organization of Country	Commodity	MRL (mg/kg)
US EPA	Cereals	1
	Pulses	0.1
	Oilseeds	0.1

**(95%Confidence Interval)*

Conclusion: The studies have shown that the maximum residue limits (MRL's) are below the strictest limits available worldwide including, Indian Standards (0.05 mg/kg of grain), Codex Alimentarius (2 mg/kg of grain), US EPA (see table 3) and EU country standards (2 mg/kg of grain). The product protects the commodity whilst MRL's remain under the thresholds even when tested under some of the most challenging conditions the product is likely to be exposed to including, high temperature, pressure and moisture.

*The residue studies were conducted under internationally harmonized accelerated conditions; hence, the results obtained for 2 weeks are in fact for 2 years. Therefore, the results are for a storage period of 2 years (2 weeks of accelerated condition) wherein the residue levels are below the Codex MRL value of 2 mg/kg of grain.

Toxicology and Risk Assessments

Human risk assessment: The use of safety accessories such as gloves and full sleeved shirts and light footwear is recommended on the label; however, for handling in households, the sacks are absolutely safe and hence no safety measures are required.

Dietary risk assessment: Based on the GEMS calculation, the % accepted daily intake is only 20–40% of the ADI of Deltamethrin. Therefore, the residues of DM in the commodities stored in the insecticide incorporated sacks will not exceed the ADI and thereby not be detrimental to human beings consuming the food.

- ☞ Oral toxicity on rats: **Globally Harmonized System (GHS) as category 5:** Safe
- ☞ Acute dermal irritation/corrosion potential was **non-irritant** to the skin of New Zealand white rabbits
- ☞ **Minimally irritating (M1)** to the eyes (New Zealand white rabbits)
- ☞ A **non-sensitizer** to the skin of guinea pigs

TABLE 4. Further risk assessment data

Air permeability (ft ³ /ft ² /min.)	>5	USDA
Heavy metals	The sum of Arsenic (As), Cadmium (Cd), Lead (Pb), Hexavalent Chromium (Cr6+), Mercury (Hg) and Antimony (Sb) is 'Non detectable' in ZeroFly® Storage Bag. The bag passes the USDA standards.	USDA
Migration of Polyolefins in PP	The migration of extractives from the polypropylene material is <1%. The material passes the US FDA Food contact substances (FCS). Overall migration after 10 days at 40°C was <2 mg/dm ²	US FDA 21 CFR Part – 177.1520 Clause 2.1 EU Com. regulation No. 10/2011
Migration of Deltamethrin	Deltamethrin 'not detectable' (ND) in wheat grains stored in ZeroFly® Storage Bags after 30 days of storage. Detection limit was 0.01.	AOAC 2007.01

Product Evidence Creation Partners

Eurofins, GLP, (EPA testing body), North Carolina, USA; International Institute of Biotechnology and Toxicology (IIBAT), GLP, Chennai, India; Nigerian Stored Product Research Institute (NSPRI), Ilorin, Nigeria; Natural Resources Institute (NRI), UK; Oklahoma State University (OSU), USA; USDA, Kansas, USA; Kenya Agricultural Institute (KARI) Kenyan Seed Company, Kenya; Direction de la protection des végétaux Senegal and Zambia Agriculture Research Institute (ZARI).

Contracted testing facilities	Results
USDA	No live insects inside bags and no damage to grain kernels detected. Contact tests with adults of the red flour beetle (<i>Tribolium castaneum</i>), lesser grain borer (<i>Rhyzopertha dominica</i>), and maize weevil (<i>Sitophilus zeamais</i>) were conducted: All adults of each species were knocked down after 24 hours & 100% mortality after a maximum of 72 hours.
Natural Resources Institute, UK	Initial evidence of high mortality with a contact efficacy test with adult Khapra Beetle (<i>Trogoderma granarium</i>) and adult and larval Indian Meal Moth (<i>Plodia interpunctella</i>).
International Institute of Biotechnology and Toxicology (IIBAT) Padappai-601301, Kancheepuram District, Tamil Nadu India iibatindia@yahoo.com; director@iibat.com	<ul style="list-style-type: none"> ➤ The institute conducted laboratory tests using field collected insect strains with 30-fold resistance to Deltamethrin. Insects were collected from local households and warehouses. ➤ The efficacy on <i>Sitophilus</i> sp. (Granary and Rice weevil) and <i>Callosobruchus</i> sp. (Pulse beetle) was established under laboratory conditions, with 100% mortality achieved after 30 minutes and 24hours exposure to the product respectively. No insects were able to bore/chew through the product. ➤ After 20 days real time exposure to Delhi Summertime conditions, the efficacy remained at 80% and 100% Mortality respectively, on <i>Sitophilus</i> sp. (Granary and Rice weevil) after a 24 hour exposure time to the product and on <i>Callosobruchus</i> sp. (Pulse beetle) after a 30 minute exposure time to the product.
Eurofins Agroservices Inc. 8909 Atkins Road Mebane, Inc. 27302 USA jingzhai@eurofins.com	<ul style="list-style-type: none"> ➤ <i>Sitophilus granarius</i> (Granary Weevil) adults: 100% mortality and knock down (after 12hrs) ➤ <i>Tribolium confusum</i> (Confused Flour Beetle) larvae & adults: 100% knock down (after 12hrs) & > 85% mortality (after 48hrs) ➤ No insects were able to chew or bore through the product
VF-NMIMR Centre for Vector Control Research University of Ghana Legon – Accra Ghana meh@vestergaard-frandsen.com	<ul style="list-style-type: none"> ➤ Contact bioassays and boring/chewing tests on <i>Sitophilus zeamais</i> (Granary Weevil) and <i>Prostephanus truncatus</i> (Larger Grain Borer) gave 100% mortality with both pests following 24hours exposure to freshly produced and weathered product (56 days; Accra, Ghana) and 100% knock down after 6 hours. None of the pests were able to bore/chew through the product.

Field and Semi-field Studies

Reducing Post-Harvest Grain Losses for Subsistence Farmers

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Study Design:

Treated and untreated bags were placed in environmental chambers and several hundred lesser grain borers, red flour beetles, and maize weevils were placed in the vicinity of the bags (external infestation), thus giving the insects a free choice of infesting treated or untreated bags. In a separate, similar experiment, about 20 adults of each of the three species were placed inside each bag (internal infestation).



Results:

Very few insects and damaged kernels in treated bags that contained no initial internal infestation (Figure 2). Also, there were fewer damaged kernels in bags with initial levels of internal infestation when stored in treated bags.

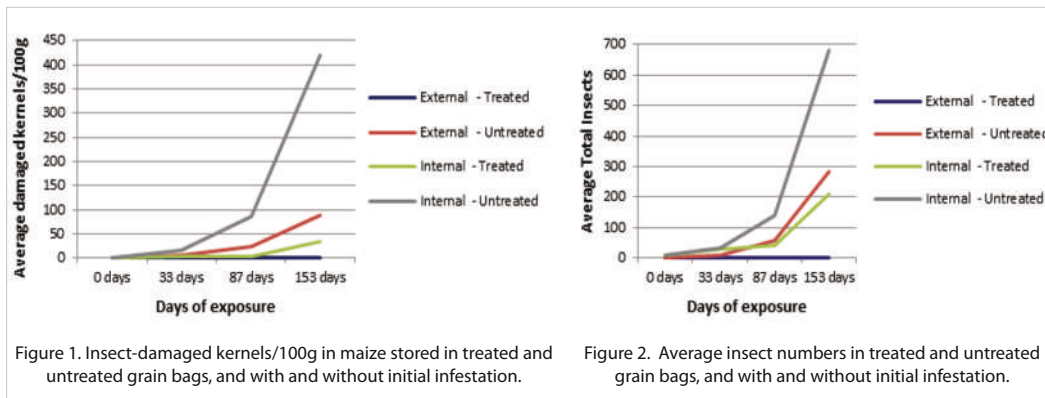


Figure 1. Insect-damaged kernels/100g in maize stored in treated and untreated grain bags, and with and without initial infestation.

Figure 2. Average insect numbers in treated and untreated grain bags, and with and without initial infestation.

Conclusions:

Insecticide incorporated seed bags can be used to prevent grain from being infested by stored grain pests, and to reduce grain losses in infested grain.



Protectant potential of ZeroFly® Storage Bag against grain damage by stored-product insect pests in Ghana

Prof. E.O. Owusu, T. Buxton and J. Ansah, SHS Consult & African Regional Postgraduate Program in Insect Science (ARPPIS), University of Ghana

Study Design:

Bioassay tests were conducted to study the efficacy deltamethrin incorporated ZeroFly® Storage Bags against *S. zeamais* and *C. maculatus*, additionally 5 and 10 kg were filled with both maize and cowpea to simulate conditions in the field. Similarly, the performance of 10 kg bags under field storage conditions was investigated, over 3 weeks, at the University of Ghana Farms, Legon. Samples of grains were sent to the Ghana Standard Authority for residue analyses.

Results:

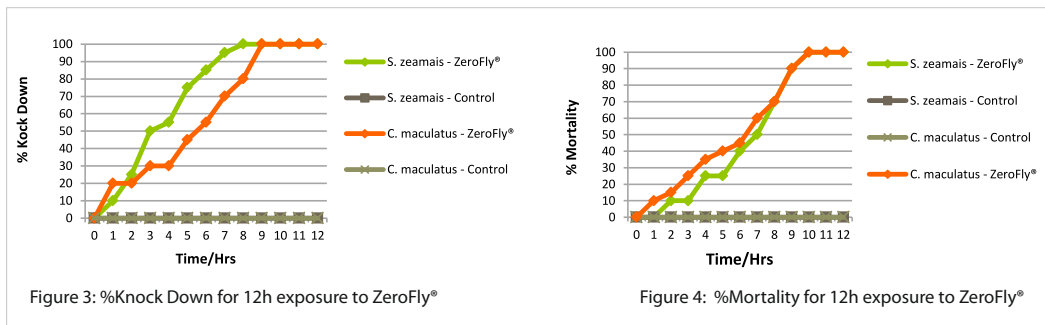


Figure 3: %Knock Down for 12h exposure to ZeroFly®

Figure 4: %Mortality for 12h exposure to ZeroFly®

Simulated Storage Conditions (Laboratory and/or Field):

TABLE 5: % Survival for pests under field and lab storage conditions

Conditions	Treatment arm	Size	% Survival \pm SE	
			<i>S. zeamais</i>	<i>C. maculatus</i>
Field	ZeroFly® Storage	10kg	2.2 \pm 0.1	8.9 \pm 1.2
	Control	10kg	85.4 \pm 2.3	97.7 \pm 6.1
Laboratory	ZeroFly® Storage	5kg	0.0 \pm 0.0	0.5 \pm 0.1
	Control	5kg	100.0 \pm 0.0	100.0 \pm 0.0
	ZeroFly® Storage	10kg	0.3 \pm 0.1	6.3 \pm 1.3
	Control	10kg	93.0 \pm 2.3	100.0 \pm 0.0

TABLE 6: % Weight loss for crops under field storage conditions

Treatment arm	Size	% Weight loss \pm SE	
		Maize	Cowpea
ZeroFly® Storage	10kg	0.00 \pm 0.0	0.00 \pm 0.0
Control (untreated)	10kg	9.37 \pm 2.13	16.24 \pm 2.28

Conclusions:

- ZeroFly® Storage bags exhibited 90.7% and 100% repellency to *S. zeamais* and *C. maculatus* and bioassays showed 100% both knock down and mortality effects within twelve hours of exposure.
- ZeroFly® Storage Bags effectively protected maize and cowpea against *S. zeamais* and *C. maculatus* respectively, yielding <8.9% survival of insects when grains were stored under both laboratory and field conditions, leading to 0% weight loss to grains as shown in Tables 5 and 6.
- Residue levels of deltamethrin (0.15 mg/kg) in grains stored in ZeroFly® Storage bags were lower than CODEX Alimentarium MRL (2 mg/Kg for cereal grains), and therefore safe for human consumption.