# ORGANIC STORED PRODUCT PEST TREATMENT USING NITROGEN DURING SHIPMENT

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Few technically feasible and economically viable non-chemical alternatives exist for the rapid disinfestation of organic products. Recent advancements in the development of nitrogen generators, plastic liners and gas monitoring equipment are making the utilization of nitrogen-based modified atmosphere an attractive alternative treatment technology. Purdue University's Stored Product Protection Team has partnered with the leading Indiana pest control company (Insects Limited, Indianapolis, IN) and with a major U.S. engineering firm (Innoventor, Marilyn Heights, MO) to address important production diversification and food quality aspects. This Nitrogen for Insect Treatment Research on Organic Products (NITRO) project focuses on the development and demonstration of a nitrogen-based modified atmosphere treatment station for the control of stored product pests in bagged organic grains and grain-based products grown in Indiana and surrounding states and designated for sale in domestic and overseas markets. The objectives of this research are: (1) To construct a transportable nitrogen-based modified atmosphere treatment station and conduct a pilot-scale trial with bagged organic grain in sealed stacks, and (2) To demonstrate the transportable nitrogen-based modified atmosphere treatment station by conducting a full-scale trial with bagged organic grain in a shipping container.

A Pressure Swing Adsorption Nitrogen generator Model HPN-25 was made available by Innoventor. Stacks of bagged product measuring 1.2 m x 0.9 m x 0.9 m were sealed inside polyethylene plastic liners, subsequently temperature sensors, gas sampling tubing, and insect cages were placed among the product bags. Access valves for the inlet purging and outlet recirculation lines for the nitrogen were incorporated into the seam of the bag. The liner material was provided by Azotox which was shipped from Germany. Nitrogen was introduced on one side of the liner enclosing each product stack that purged its content with 99.99% and maintained for 3, 7 and 21 days. During the treatment time, temperature was monitored continuously at points where gas concentration was measured. Oxygen level was monitored using zirconium type oxygen analyzers provided by Azotox at two locations every hour. Bioassays of live adult Indianmeal moth, maize weevil, red flour beetle, and lesser grain borer were placed among the bags in three locations in each stack. Bioassays were collected at the end of each treatment and live vs. dead insects were counted. Experiments at a larger scale using a 20 ft container are currently being conducted.

Based on laboratory studies on use of nitrogen for modified atmosphere storage with stacks of bagged product, this system was able to eradicate adult Indianmeal moth, maize weevil, red flour beetle, and lesser grain borer in the bioassays. Results showed 100% mortality was achieved for all insects within three days at low oxygen concentrations (less than 0.24%). Extending the duration of the treatment to seven days, low oxygen concentrations were maintained at less than 0.6% and for the 21 day trials it was less than 4.5%. Similar with the shorter period of storage, no live insects were observed. The growth material from the bioassays were sieved and kept for two months at room temperature ($27^{o}$C). Weekly sieving of the material showed no eggs nor larvae survived within the two months that these materials were kept.

Further studies are being conducted with the use of 20 ft containers. Longer treatment periods during shipment will be conducted at the same time monitoring systems for gas concentrations are being evaluated.

The advantages of the NITRO system are:

- uses no chemicals for treatment of commodities
- lower in cost compared to use of nitrogen tanks
- can easily be implemented
- treatment is being done while product is being shipped

The problems or challenges encountered in implementation are:

- availability of oxygen monitoring devices that requires no pump and reliable enough for product shipment
- ensuring proper seal of the liners to minimize oxygen infiltration
- making and installing the large liner bag (measuring 9 m x 4.8 m) into the container without puncturing it