

8. Stored product pests

8.1 Official examination of consignments 2002

DPIL examines consignments of grain and other dried plant products intended for export. Based on the results of these examinations, the Plant Directorate of the Ministry of Food, Agriculture and Fisheries issues a phytosanitary certificate for countries requiring such certification. In 2002 a total of 1095 consignments were examined: 152 lots of grain, 73 lots of malt, 109 lots of pulses (dried peas and beans), 184 lots of tobacco and 577 consignments of other products. Live insects were found in a total of 5 lots, in all cases in lots of grain and malt. The following pests were found: *Sitophilus granarius*, *Oryzaephilus surinamensis*, *Tribolium confusum*, *T. destructor* and *Cryptolestes ferrugineus*.

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8.2 Rapid analysis methods for detection of pests and moulds in stored grain

The potential for detecting mites and mycotoxins in grain by the means of near infrared transmittance spectroscopy is being investigated in a three-year project supported by the Nordic Industrial Fund. Participants in the project are scientists and representatives from instrumental industries and cereal industries in Sweden, Finland, Norway and Denmark.

The DPIL is responsible for the subproject concerning storage mites. Before calibration curves can be developed, a reliable reference method must be established. Precise and reproducible determination of mite densities is very difficult. A flotation method has been established and analyses conducted using grain samples seeded with the grain mite, *Lepidoglyphus destructor*, in densities ranging from 600 to 25,000 mites per kg grain. The method is being adjusted to improve recovery rates and minimize the variation.

The progress of the project will be reported on www.hurtiganalys.com.

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8.3 Storage pests in Northern Guinea Savannah of Benin in West Africa with special reference to the Angoumois grain moth *Sitotroga cerealella*

The present work aims at elucidating the role of *S. cerealella* as a pest of stored maize. Although *S. cerealella* has been relatively well studied as a pest of sorghum, its population dynamics, destructive potential and ecological relations (including natural enemies and pathogens) as a pest of maize in West Africa are not well understood.

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8.3.1. The role of *Sitotroga cerealella* as a post-harvest pest in the Guinea Savannah region in Benin

In 10 different locations in the Guinea Savannah of Benin 50 maize farmers were surveyed. The surveys were undertaken between June 2001 and September 2002. Five farmers were chosen in each village for an initial exploratory questionnaire. This was followed by four surveys in the stores, carried out in the first, third and sixth months, respectively, after the first one. From each store, 60 cobs were taken and evaluated to study pest and predator densities, evaluate losses and damage levels. Hidden immature stages including natural enemies in the grains were reared out at IITA's experimental station in Cotonou, Benin. Furthermore, in four villages experimental granaries were established to study the effect of storing maize with husk, without husk and as grains on storage pest dynamics.

At the end of the survey *P. truncatus* and *S. zeamais* were found in all stores surveyed in Southern Guinea Savannah. In Northern Guinea Savannah *P. truncatus* was found in 25% of the stores. *S. zeamais* was rarely observed. In all sites *Sitotroga cerealella* was absent. The natural enemy of *P. truncatus*, *Teretriosoma nigrescens* was found in all stores in which *P. truncatus* was found. Three natural enemies of maize weevil, *Anisopteromalus calandrae*, *Lariophagus distinguendus* and *Theocolax elegans* were found in all sites where *S. zeamais* was present. Maize weight losses reached 10-15% at the end of survey. The problem of storage fungi arises especially in the southern part of the Southern Guinea Savannah and the fungi most frequently found were: *Fusarium* spp., *Penicillium* spp. and *Aspergillus* spp.

The absence of *S. cerealella* was in clear contrast to some areas of Nigeria where the moth is common and often reaches pest status on stored sorghum and maize. Although *S. cerealella* was absent, the data give valuable insight into pest relationships in stores of maize in Benin. Data will be used to update the grain-storage model developed in cooperation between IITA and the Danish Institute of Agricultural Sciences (DIAS).

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8.3.2. Developmental time and age-specific fecundity of *Sitotroga cerealella* in relation to temperature and relative humidity

The developmental time and age-specific fecundity of *Sitotroga cerealella* was determined in the laboratory at combinations of four temperatures (20°, 25°, 30° and 35°C) and two levels of relative humidity (low (44% RH) and high (80% RH)). Some results are reported here: developmental times (egg to adult moth) ranged between 37 days at 30°C, high RH, to 105 days at 20°C, low RH. Fecundity was highest (mean 123 eggs per female) at 20°C, high RH. At 35°C, juvenile survival as well as oviposition were negligible. The data were used to calculate population development parameters; the highest intrinsic rate for natural increase, r_m , was found at 30°C, high RH.

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8.3.3. Intra- and interspecific competition between *Sitophilus zeamais* and *Sitotroga cerealella*

Competition experiment. *Sitophilus zeamais* and *Sitotroga cerealella* are two important pests on maize in West Africa. Previous studies have demonstrated that *S. zeamais* is the dominant species and eliminates *S. cerealella* in laboratory experiment. Nevertheless, the two species are found coexisting in nature.

As part of an M.Sc. project the question of coexistence was assessed in a competition experiment where resources were divided into discrete patches. It was hypothesized that coexistence would be sustained if the more fugitive species *S. cerealella* could reach and exploit new uninfested resources before *S. zeamais*. This hypothesis was rejected since *S. zeamais* dispersed more rapidly to the uninfested grains. The results of the competition experiment did not explain the coexistence, but by incorporating a spatial dimension new information on the mechanisms of competition was revealed. Furthermore by fitting of a logistic model to the data an estimate of the intrinsic rate of natural increase for *S. zeamais* was obtained ($r \approx 0.380$ per week).

Maximising progeny production – a laboratory experiment. The eggs of *S. zeamais* are deposited within the grains and the four larval instars develop and feed inside the grains. When adult *S. zeamais* exploit the grains they may damage the larvae inside. An additional experiment was conducted in order to study whether the distribution of adult *S. zeamais* was influenced by the presence of larvae inside the grains. It was found that adult *S. zeamais* avoid grains which contain a third or fourth instar larvae.

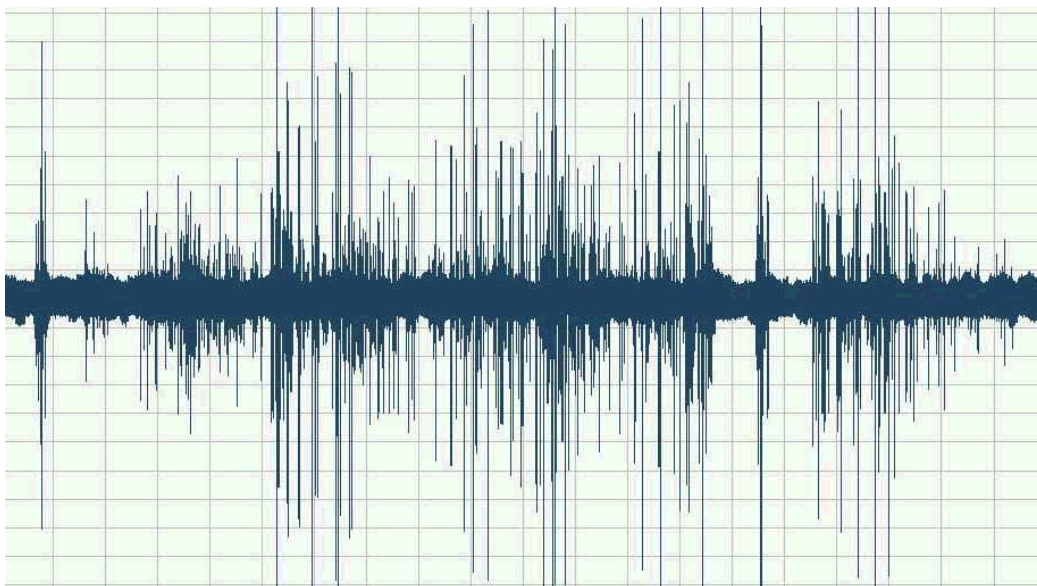
Species composition - a field study. Insects on maize cobs sampled from stores in Benin were identified. The species list contains 14 insect orders. Within the Coleoptera 30 species were represented and within the

Hymenoptera 8 species were identified. *S. zeamais* was found in high numbers, but no *S. cerealella* were found, which was in line with data obtained by IITA in Benin. Correlations between the pest species, their natural enemies and different explanatory variables affecting the species composition in a maize store were examined.

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8.4 Acoustical monitoring of insect pests in stored products

The purpose of this project is to develop a fast, reliable and sufficiently sensible method to monitor the presence of insect pests in the cereal industry. The grain weevil *Sitophilus granarius* is the most important pest in stored grain in Denmark. It is possible to measure its activity based on noise it produces during movement or chewing inside the kernels. A correlation between the level of activity and the sound recorded



Sound recording from a grain beetle larvae in a wheat kernel

will be determined. In a series of experiments single grains have been cut open and the behaviour of the larvae has been recorded on video tape simultaneously with the sound produced. By the means of computer-based video and sound analysis it will be possible to describe the sound produced by specific behavioural elements.

The confused flour beetle *Tribolium confusum* is a major pest in industrial flour mills, where it congregates in large numbers in heat producing machinery. A new experimental set-up will be constructed to reveal whether it is possible to detect this insect based on the sound or vibrations that it produces.

The transmission of sound through grain has been determined in a set-up where a loudspeaker was used as the sound source and the attenuation was measured at different distances. These investigations revealed a relatively large attenuation, probably due to the limited amount of free air space between the grains. The plan is to continue these measurements with vibrations instead of sound. Initial experiments have shown that an accelerometer attached to a thin metal plate provides an efficient connection to the grain.

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