Grain storage in a small-farm ecosystem: Angoumois grain moth movement and management

R.J. Barney and P.A. Weston*

Abstract

Sitotroga cerealella (Olivier), the Angoumois grain moth (AGM), is found worldwide, both preharvest and in postharvest storage of grains such as wheat, rice, maize (corn), millet, and sorghum. Many other non-crop, plant hosts have been found, and others probably exist. In addition to having flexible nutritional requirements, AGM is highly mobile and a primary coloniser. These attributes allow it to survive in a variety of habitats and move from patch to patch as conditions change.

More than 40 000 Angoumois grain moths were captured during the two plus years: 35 713 in pheromone traps and 5203 in bin-vent traps. AGM activity at the bins and at the greatest distance from the bins (550 m) preceded moth activity at maize fields.

Introduction

The Angoumois grain moth (AGM), *Sitotroga cerealella* (Olivier), has been recognised as a grain pest for over 250 years. It is found worldwide in both preharvest and postharvest storage of such grains as wheat, rice, maize (corn), millet, and sorghum. Many other non-crop, wild-plant hosts have been found (Joubert 1966), and others probably remain to be discovered. Moths have even been found in a forest about 5 km from the nearest storage facilities or fields (Cogburn and Vick 1981).

In addition to having flexible nutritional requirements, AGM is highly mobile and a primary coloniser. These attributes allow AGM to survive in a variety of habitats and move from patch to patch as conditions change. Simmons and Ellington (1933) hypothesised that in Maryland, AGM move from grain storages to ripening wheat fields in summer. Stockel (1971) reported that in southwest France, AGM produce three generations per year: the first two in grain storage or wild grasses and the third on ears of maize in the field.

The Angoumois grain moth was first recognised in Kentucky as a pest of wheat in 1852. Recent survey work in Kentucky has revealed AGM as the most significant moth pest of on-farm, stored, shelled maize. Central Kentucky, located in the Inner Bluegrass, is a rural area of gently rolling hills underlain by limestone. Although the Bluegrass is known for its horses, burley tobacco and bourbon, Kentucky on-farm, grain-storage capacity averages 190 million bushels (Kentucky Agricultural Statistics 1992). Kentucky ranks forth in the nation in number of farms (91 000 farms averaging 63 ha), signifying the preponderance of small, family farms in the state.

The abundance and spatial distribution of insects in agricultural landscapes is seldom static, with populations typically moving through multiple habitats over the course of a season (Landis 1994). From a grain moth perspective, a typical small farm is a patchwork of prime habitats (maize fields and storage bins) and less stable or less desirable habitats (wild/alternative hosts, livestock feed, grain spills). From a grain grower/manager perspective, a farm is a patchwork of prime manageable, revenue-producing habitats (maize fields and storage bins), manageable, but nonrevenue-producing habitats (wild/alternative hosts, livestock feed, grain spills), and unmanageable, nonrevenue-producing, off-farm habitats.

The purpose of this study was to monitor AGM movement among these habitats on a small, central Kentucky farm. The objectives were: (1) to determine temporal patterns of AGM movement, (2) to determine spatial patterns of AGM movement, and (3) to determine if knowledge of these patterns has management implications.

Materials and Methods

The experiment was conducted at the Kentucky State University Research Farm, Franklin County, KY in 1991, 1992 and 1993. The 83-ha farm is primarily used for vegetable plot studies and livestock grazing. A stored-grain, bin complex is located near the centre of the farm and plots of maize were grown at various locations on the farm each year.

At the initiation of the experiment (July 1991), shelled maize was stored in a bin complex, consisting of two 1000-bu bins and 12 300-bu bins. All bins held 'DeKalb 689' hybrid, with the large bins containing maize harvested in November 1988 (three-year old) and the smaller bins containing maize harvested in November 1989 (two-year old). Maize in the small bins remained in place throughout the experiment while the large bins were refilled every other year.

The trapping regime consisted of two parts: monitoring AGM in and around the storage structures with sticky traps in the top vents of the bins, and monitoring AGM activity across the farm and near maize plots with pheromone traps arranged in a circular grid, radiating throughout the farm with the storage complex as the centre.

The first series of traps ('bin-vent traps') were 76 × 127 mm (611 × 1211) yellow, double-sided, sticky traps (Olson Products, Medina, OH). The traps were suspended with clamps from wire grates within the vents. Each trap (n = 10) was exposed on both sides, thereby having one side facing the inside of the bin and the other facing away. Traps were monitored from 27 September to 8 November 1991 in eight bins. The same bins were monitored from 15 May to 13 November 1992 and from 31 March to 3 November 1993.

The second series of traps were delta-style, sticky-board insert, AGM pheromone traps (Insects Limited, Indianapolis, IN). Traps were arranged in concentric rings of 65, 175 and 400 m from the bins. Traps were attached to wooden stakes at a height of 1.3 m and located at the four cardinal compass

* Atwood Research Facility, Kentucky State University, Frankfort, Kentucky 40601 USA.

points, next to maize plots, and other locations. Traps (n = 17) were monitored weekly from 23 August to 8 November 1991. In 1992 paired traps (n = 34) were located at 65 400 and 550 m to provide replication and cover a greater portion of the farm. Traps were sampled from 22 May to 13 November 1992 and from 30 April to 12 November 1993.

All traps were monitored weekly, and inserts were replaced as necessary. Insects were counted without removing them from the sticky surface.

Results

Greater than 40 000 Angoumois grain moths were captured during the two plus years: 35 713 in pheromone traps and 5203 in bin-vent traps. The pheromone-baited traps were much more efficient at catching moths than passive, non-baited sticky traps.

AGM activity at the bin-vents was greatest in July during 1992, with activity decreasing each month until frost (Fig. 1A). In 1993 the activity showed the same general distribution, but peak activity was delayed until August.

Male moth activity across the farm, as measured by pheromone trapping, was very heavy during September and October each year (Fig. 1B). Field activity was concentrated in and around maize plots from August to November.

Results from trapping at different distances and directions from the bins were inconclusive. Activity at 550 m was very high (>70 AGM per trap) in July 1992 and August 1993; this is the same time that activity peaked at the bins.

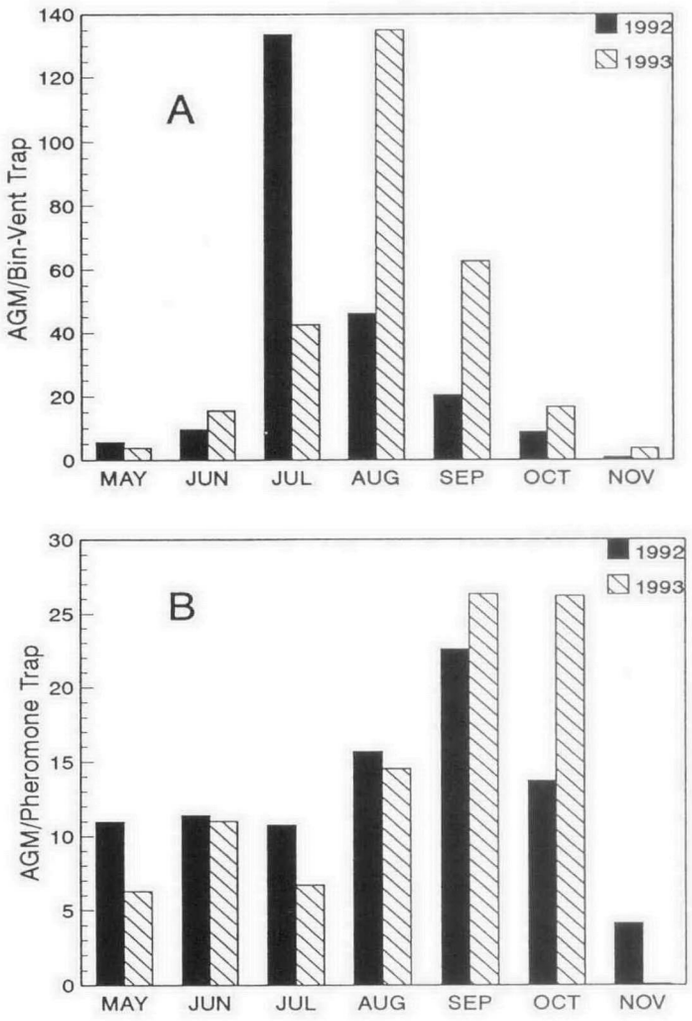

Fig. 1. Trap catches of angoumois grain moth. (A) bin-vent trap; and (B) pheromone trap.

Discussion

A study of planting date influence on preharvest infestation of maize by AGM in central Kentucky (Weston et al. 1993) outlined some management options based on ovipositional behaviour. Combined with the trapping data in the present study, the following scenario in central Kentucky is suggested:

May–June	moths in storage become active
July–August	large moth exodus from bins high activity at 550 m, off-farm, wild hosts
August–September	activity centred at maize fields
September–October	oviposition in field
October–November	harvest/binning of infested grain.

Temperature changes between years will shift events to earlier or later in the season.

Many insects require one type of habitat for overwintering and one or more additional habitats for feeding, mating, resting, and oviposition. Patches in close spatial association frequently constitute a source/sink relationship. For the Angoumois grain moth, storage, fields, and wild hosts can each serve as both source and sink, depending on the time of year. The association of these habitat patches in both time and space is a critical feature of the functioning of an agricultural landscape (Landis 1994). These aspects must be considered when designing an ecologically-sound, arthropod management system.

References

Cogburn, R.R. and Vick, K.W. 1981. Distribution of Angoumois grain moth, almond moth, and Indian meal moth in rice fields and rice storages in Texas as indicated by pheromone-baited adhesive traps. Environmental Entomology, 10, 1003–1007.

Joubert, P.C. 1966. Field infestations of stored-product insects in South Africa. Journal of Stored Products Research, 2, 159–161.

Kentucky Agricultural Statistics 1992. Kentucky Agricultural Statistics Service, Louisville, KY.

Landis, D.A. 1994. Arthropod sampling in agricultural landscapes: ecological considerations. In: Pedigo, L.P. and Buntin, G.D. ed., Handbook of sampling methods for arthropods in agriculture. Boca Raton, CRC Press, 15–31.

Simmons, P. and Ellington, G.W. 1933. Life history of the Angoumois grain moth in Maryland. United States Department of Agriculture Technical Bulletin, 351, 1–34.

Stockel, J. 1971. Utilisation du piegeage sexuel pour lletude du deplacement de l'alucite *Sitotroga cerealella* (Lepidoptera: Gelechiidae) vers les cultures des mais. Entomologia Experimentalis et Applicata, 14, 39–56.

Weston, P.A., Barney, R.J. and Sedlacek, J.D. 1993. Planting date influences preharvest infestation of dent corn by Angoumois grain moth (Lepidoptera: Gelechiidae). Journal of Economic Entomology, 86, 174–180.