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09 - Some like it hot – some not: Differences in temperature preference of two parasitic wasp species

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Abstract

Insect pests not only cause damage to crops in the field but also to stored products. One of the major pests in stored grain in Europe is the granary weevil *Sitophilus granarius* (L.).

The most commonly used biocontrol agent against this and other pests developing inside kernels or cocoons is *Lariophagus distinguendus* (Förster) a parasitic wasp belonging to the family of Pteromalidae. Another parasitic wasp of that family is *Anisopteromalus calandrae* (Howard). Even though the two wasp species show very similar host finding and parasitisation behaviour, field experiments reveal that *L. distinguendus* and *A. calandrae* have different temperature requirements. Whereas parasitisation in *L. distinguendus* can already be observed at weekly mean temperatures of 9°C to 10°C, *A. calandrae* needs weekly mean temperatures of at least 11°C to 12°C. On the other hand, *L. distinguendus* is affected by high temperatures more easily than *A. calandrae*. Laboratory experiments under different constant temperatures confirm this finding. These findings suggest a temperature dependent release of either *L. distinguendus* or *A. calandrae*. At mean temperatures below 19°C, *L. distinguendus* should be used, at higher temperatures *A. calandrae* performs better.

Introduction

Insect pests are a threat to stored products. Despite preventive methods such as ventilation and cleaning infestations with stored product pests can not always be avoided. These pests are not only responsible for losses in weight and quality but can also cause health problems. With the rapid decline of available active substances against stored product pests in the last couple of years, especially the phase out of methyl bromide in 2005, a huge challenge is posed for pest control in the future. Alternative methods such as the use of sulfuryl fluoride, controlled atmospheres and heat treatment require sealed buildings or bins with a high degree of gas tightness and are often cost and energy intensive. Therefore these methods are only applicable in the food processing industry or large mills and storages. A good alternative for small scale farms is the biological control of the storage pests. Thereby, the use of beneficial insects against storage pests has many advantages. There is no registration required, there are no resistances and beneficials are easy to apply. Today a number of beneficials against different stored product mite, moth and beetle species is commercially available.

One of the major pests in stored grain in Europe is the granary weevil *Sitophilus granarius* (L.). The most commonly used biocontrol agent against this and other pests living inside kernels or cocoons is *Lariophagus distinguendus* (Förster), an idiobiontic ectoparasitic wasp belonging to the family of Pteromalidae. Another parasitic wasp of this family is *Anisopteromalus calandrae* (Howard). They both use their ovipositor to drill holes in e.g. grain kernels, paralyse the host larvae within the kernels and place an egg on the outside of the host larva. The wasp larva develops on the outside of the host while sucking it out. Finally the wasp larva pupates and hatches. This life-cycle makes these wasps good biocontrol agents.

Whereas the general suitability of *L. distinguendus* and *A. calandrae* for the biological control of stored product pests has been demonstrated (Steidle et al., 2002; Reppchen et al., 2002;) , there are still a number of open questions. Therefore, the present study aims to look at the temperature preferences of *L. distinguendus* and *A. calandrae* and the consequences for their application in biocontrol.

To gain information about temperature conditions in storage buildings, temperature measurements where conducted in different storage buildings in southern Germany for more than three years. It could be shown that there are huge variations in temperature during the year reaching from -10°C in the winter (Fig. 1) up to +48°C in the summer (Fig. 2) mostly in poorly insulated buildings. Even during the day high variations of about 20°C were measured (Fig. 2).

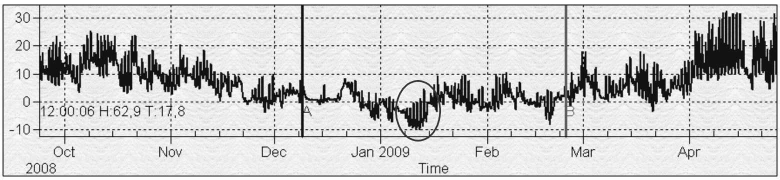

Fig. 1 Temperature data from a storage building in Stuttgart/Germany recorded from October 2008 to April 2009 with an PCE-HT110 data logger showing temperatures down to -10°C in January 2009

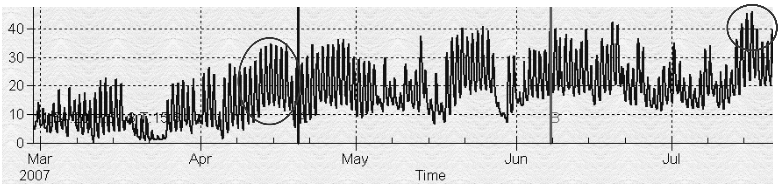

Fig. 2 Temperature data from a storage building in Stuttgart/Germany recorded from March to July 2007 with an PCE-HT110 data logger showing temperatures up to 48°C in July 2007 and temperature variations of more than 20°C at one day in e.g. April 2007

To investigate the behaviour of the wasps at different temperatures the reproduction rate of the wasps plotted against temperature was investigated in field and laboratory experiments. Therefore fertilized females of *L. distinguendus* as well as fertilized females of *A. calandrae* where kept in Petri-dishes with 10g of grain infested with *S. granarius* larvae. Adult wasps were removed after one week and the grain containing parasitized *S. granarius* larvae was incubated at 25°C. Afterwards the number of offspring was counted. Temperature conditions where either natural conditions in storage buildings, recorded with a temperature-humidity data logger or constant temperatures in an incubation chamber. It could be shown that L. distinguendus performs better at lower temperature whereas *A. calandrae* performs better at higher temperatures.

These results of this study suggest a temperature dependent release of *L. distinguendus* and *A. calandrae* to guarantee the best results in the attack of stored product

Acknowledgments: We would like to thank the Federal Program of Organic Farming (BÖL) of the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV) for funding (Project number O5OEO4O).

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10 - Physical control of stored product insects

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Abstract

Given the declining number of chemical agents for pest control, non-chemical methods gain importance in stored product Integrated Pest Management. Physical methods play an important role not only in pest control, but also in pest prevention (e.g. product cooling, drying, insect-proof storage and packaging) and pest monitoring (e.g. measurement of temperature, product density, movement or bioacoustics). In pest control, heat disinfestation has become an established method for empty structures. A difficulty is that insulators such as large amounts of flour, dust or bag stacks with products need to be removed prior to treatment. Freezing at temperatures of minus 18°C is a method to disinfest high-value products without the risk of deteriorating product quality. However, energy costs may be the limiting factor. For fine and powdery goods such as flour, sieving and milling is the only choice because just mechanical methods can lead to effective pest control in this substrate. In future, processing steps leading to pest control (e.g. heating, milling, extrusion) should be combined with pest exclusion, ventilation and temperature management in order to keep product quality high and pest control efforts at a minimum.

Key words: control, heat, cold, impact, sieving

Introduction

In the last decades, chemical means of pest control in bulk products have been the most important methods of pest control. However, the development of resistance is a threat to phosphine fumigation in grain. Recently, dichlorvos (DDVP) used in insecticidal fogs and evaporation strips was banned by the European Union due to the wish to reduce residue levels on treated products. Furthermore, new concerns on fluoride residues prompted the European Union to reduce the tolerated maximum residue levels in nuts, grain and grain products and dried fruits which reduced the availability of sulfuryl fluoride in stored product protection mainly to structural treatments. Because stored product protection is a rather small market for pesticides with stiff requirements regarding workers safety and residue levels, a significant increase in chemicals available for this purpose seems not probable in the near future. The lack of chemical means of pest control increases the need to prevent and detect pests and renders non-chemical methods of pest control more attractive.

Physical methods to prevent or detect infestation: Physical methods are important means to prevent, detect and control stored product pest within the concept of Integrated Pest Management (IPM) and Integrated Stored Product Protection (see fig. 1). If one thinks of staple food such as grains or pulses, cleaning, drying, and cooling are physical processes essential to keep a durable product in good quality during prolonged storage periods (Vincent et al. 2002). The drying process could be utilized to control pest arthropods that may have found their way into the grains provided that a uniform temperature above some 55°C is achieved for 60 min or 60°C for about one minute. Cooling to temperatures below 13°C prevents insect development and is thus another method to provide safe storage conditions (Fields 1992). This method is used for grain storage not only by organic farmers and its importance may increase due to the loss of dichlorvos emitting strips for stored product moth control in 2007.

Insect-proof or hermetic storage structures or enclosures prevent the immigration of pests and thus could reduce efforts for pest control provided the stored goods are free of living insects at the time of reception. Insect-proof packaging is the only means of pest prevention on the way from processing to consumption, and e.g. some chocolate bar producers have improved the quality of their packages in recent years changing from a wrap with aluminium foil and paper to a gas-tightly sealed plastic film. A recent test of different packaging films to the attack by various stored product insects was published by Riudavets et al. (2007).

For pest monitoring and detection, thermometers are used widely in commercial bulk grain storages to detect heat produced by metabolic activity. Further physical parameters that could be used for pest detection are product moisture content, and movement. In rice grains, optic systems using the NIR spectra are used to remove discoloured