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Short note

Accumulation of pest-arthropods in grain residues found in an empty store

Akkumulation von Schadinsekten in Getreideresten in einem entleerten Speicher

KUČEROVÁ, Z., R. AULICKÝ, V. STEJSKAL
Research Institute of Crop Production, Department of Stored-Product Pest Control, Drnovská 507, 161 06 Prague 6, Czech Republic

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Summary

The aim of this work was to explore the species composition and abundance of mites and insects in grain residues in an empty grain store. Sampling was done the first and the fifth week after unloading of the wheat grain from the store.

In the study, altogether 26 species of arthropods (Acarina, Psocoptera, Hymenoptera, Coleoptera) were found in the grain residues. Primary and secondary pests created 84 % and predators and parasitoids represented altogether 16 % of the whole arthropod's community. Primary pests *Acarus siro* and *Sitophilus granarius* were dominant. This study documented the accumulation and increase of pests in residues of old grain after unloading the grain-store. The number of individuals increased 3–450 times within 1 month depending on the species. The practical importance of the "empty-store-management", which usually escapes the attention of farmers is highlighted.

Key words: mites; insects; pest accumulation; empty store management

Zusammenfassung

In der vorliegenden Arbeit wurden Artenzusammensetzung und Abundanz von Milben und Insekten in Getreideresten in einem entleerten Speicher untersucht. Die Probenahmen erfolgten in der ersten und fünften Woche nach der Entleerung des Weizenlagers. Es wurden insgesamt 26 Arten Arthropoden (Acarina, Psocoptera, Hymenoptera, Coleoptera) in den Getreideresten gefunden. Primäre und sekundäre Schädlinge hatten einen Anteil von 84 % und Prädatoren und Parasitoide von 16 % am Gesamtvorkommen der Arthropoden. Die primären Schädlinge *Acarus siro* und *Sitophilus granarius* überwogen. Die Ergebnisse dieser Untersuchung dokumentieren die Anhäufung und Zunahme der Schädlinge in alten Getreidekörnern nach Entleerung des Speichers. Die Zahl der Individuen erhöhte sich 3- bis 450-fach innerhalb eines Monats je nach Art. Die Bedeutung für die Praxis des Managements von leeren Getreidespeichern, der die Farmer normalerweise keine Beachtung schenken, wird hervorgehoben.

Stichwörter: Milben; Insekten; Akkumulation von Schädlingen; Management leerer Getreidespeicher

1 Introduction

One of the important tasks of crop production is the protection of cereal plants during vegetation against various field pests. After a successful harvest, it is even more important to prevent grain from possible damages caused by stored-product grain pests – fungi, arthropods and rodents (Kučerová and Stejskal 1994; Kučerová 1999, 2002). Often little attention is paid to pest management in empty stores. But are they really empty? There exist several ways of infestation of newly stored grain by pests. One of them is an infestation of a newly stored crop from the old residues (= deposits = sweepings) of grain left in the empty stores from the previous storage season/harvest (Liscombe and Watters 1962; Barker and Smith 1987). It was found during faunistic research of grain stores in the Czech Republic (Žďárková 1998; Werner et al. 1999) that many grain stores were not sufficiently cleaned before storage of a new crop. Thus, grain residues are an ideal shelter and reproduction site for various stored-product pests. These pests are hidden in the undisturbed microhabitats of grain stores and usually overlooked for a long time. In the studies mentioned above, information is missing on temporal dynamics of pest populations in grain residues in empty stores between consecutive harvests. Therefore, the aim of this case study was to document (i) the accumulation and increase of pests in residues of old grain and (ii) the species composition of storage arthropods in the grain residues. The importance of pest management in empty stores is discussed.

2 Materials and methods

2.1 Storage environment

We analyzed the dispersion and accumulation of arthropods in grain residues in an empty hangar grain store in the Czech Republic (Central Bohemia) during spring 2002. The grain store (56 × 17 m) had a double-wall construction (1 m distance). The outer wall was made of corrugated metal plates, the inner wall from wooden boards. Grain residues accumulated in wall interspaces during the storage period. The ambient air temperature in the empty store was measured by a Tinytalk II digital thermometer.

2.2 Sampling

Ten sampling points (distances 3–5 m) were established in the wall interspaces of the empty grain store. Altogether 20 samples of grain residues (200 g each) were collected. The first sampling of grain residues was done 1 week after the grain was unloaded from the hangar (i. e., 28.04.2002) and the second one 30 days later (i. e., 27.05.2002). No store-cleaning was carried out between both sampling events. Samples were analyzed in the laboratory. Half of each sample was placed on Tullgren funnel (exposure 24 h) to extract mites (Acarina) and small insects (Psocoptera). The rest of each sample was placed on the sieving machine (exposure time 2 min, mesh size 1 × 1 mm). The insects (Coleoptera, Hymenoptera) were then picked up and determined. Quantitative data on the frequency of particular species were recalculated to become comparable (e. g., related to 1 kg of grain). The data obtained were used for further statistical evaluation (S-plus, Wilcoxon Ranch test, Hebák and Hustopecký 1990).

3 Results

3.1 Quality and quantity of infestation

Altogether 26 species (Acarina – 7, Psocoptera – 2, Coleoptera – 15 and Hymenoptera – 2) of arthropods were found in grain residues (Fig. 1). Mites created 27.5 % and beetles 57.5 % of all arthropod species found. The number of arthropod species increased from first to second sampling 1.7 times (Fig. 2). Primary and secondary pests represented the highest proportion (80 %) of the specimens found in the grain residues. Primary pests *Acarus siro* (500 spec./1g) and *Sitophilus granarius* (30 spec./1g) were dominant.

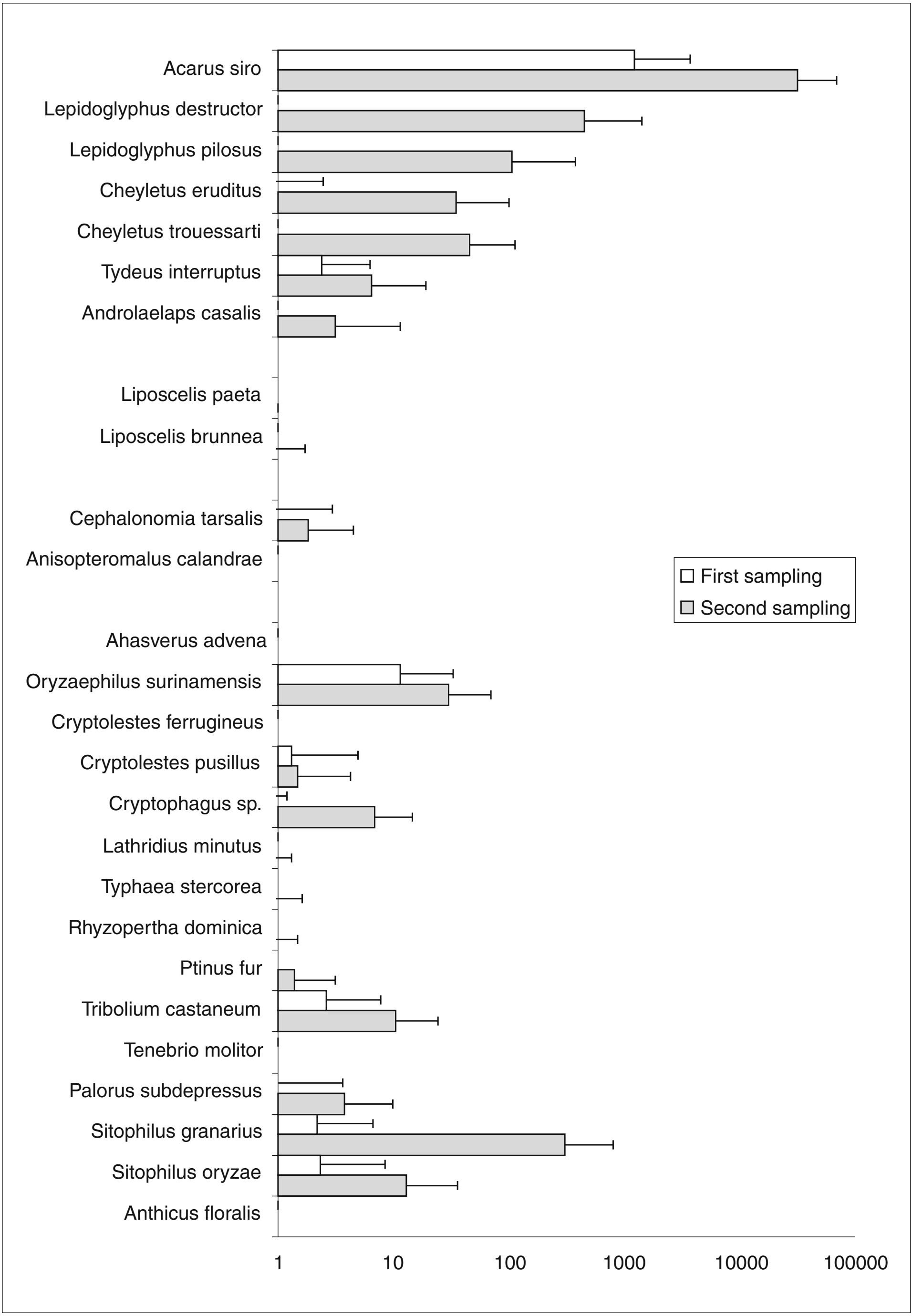

Fig. 1. Arthropod species found in grain residues in an empty grain store in the Czech Republic (abundance = number of specimens/l kg of grain residues).

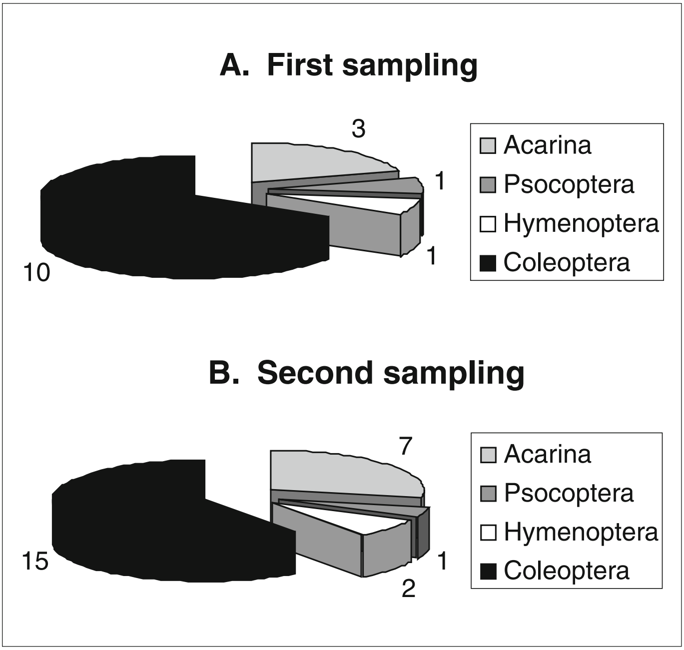

Fig. 2. Number of arthropod species in grain residues 1 week after harvest (A) and 5 weeks after harvest (B).

3.2 Accumulation of pests in residues with time after emptying the store

Number of specimens in most species increased with time. The temperature continuously increased between the first (i. e., day average 11 °C) and the second sampling (i. e., day average 18 °C). Minimal temperature was 5.8 °C and maximal temperature was 25.2 °C. The differences in pest infestation of grain residues between first and second sampling are shown in Figure 1. We found significant differences (Wilcoxon Ranch test) in numbers of specimens of primary pests extracted from the first and the second grain residue samples: *S. granarius* (P = 0.0015) – 100 times increase; *Lepidoglyphus destructor* (P = 0.006) – 450 times increase; and *A. siro* (P = 0.0006) – 25 times increase.

4 Discussion

4.1 Quality and quantity infestation

The species recorded in the grain residues do not differ from that usually found in full grain stores in the Czech Republic (Žďárková 1998; Stejskal et al. 2003). However, there are great differences of pest abundance in grain residues and stored grain mass: the comparison of our data and the data obtained by Stejskal et al. (2003) shows that the primary pest species (e. g., *A. siro* and *S. granarius*) had much higher abundance (1000 times) in grain residues than in grain mass most probably because of pest spatial accumulation and "concentration" in empty stores.

4.2 Accumulation of pests in grain residues

The accumulation of pests in grain deposits during the time of observation was caused at least by two factors. First, via aggregation of pest specimens in residues in empty stores. Second, via multiplication of pest specimens in these residues. The multiplication can be accelerated by immigration (i. e. via aggregation in this case) since it is known that the rate of population growth is increasing with increasing size of initial population (i. e., Allee effect, e. g., Scheuring 1999). In this study, we were unable to estimate the relative contribution of both factors in the particular species. Thus, we can only hypothesize that in mites the multiplication may play a greater role than immigration. Generally, mites have a potential for very rapid increase while their mobility is rather low. A different situation may be expected in the larger beetles. For example, the population increase of *S. granarius* between sampling events (i. e., 100 times increase per 30 days) may indicate the importance of aggregative movement in this species. The reproductive capacity of *S. granarius* alone cannot explain such a population increase within just 1 month. Pest dispersion and aggregation is influenced by many factors that include food/refuge-seeking behaviour (Wakefield 1995; Stejskal and Kučerová 1996), and escaping behaviour triggered by irritation (Southwood 1955; Cogan 1990). All types of behavioural stimuli can be found during and after the emptying process of a grain store: i. e., (i) movement of the grain may trigger escaping behaviour of pests; (ii) absence of grain mass in the empty store can increase food and refuge seeking behaviour of pests. Surtess (1965) found that the pest aggregation occurs most frequently at sites where disturbance was at the minimum. Grain residues offer such conditions in an empty store. Temperature also plays an important role in pest behaviour (Cox and Collins 2001). In our case, the increase of the ambient temperature between sampling events probably contributed to the increase of locomotory activity and multiplication of pests.

5 Conclusions

Usually, farmers focus mainly on the control of an infestation in stored grain while the occurrence of pests in empty stores escapes their attention. However, in our case, the detected numbers of grain pests in residues were high enough to cause potentially serious infestations of a new crop. This indicates the need for implementation of an integrated “empty-store-management” that should include mechanical, biological (Žďárková and Horák 1990) and chemical control of pests in empty stores between harvests.

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