Comparison between two methods of insect sampling in stored wheat

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Abstract

Sampling techniques for insect detection on bulk-stored grain can provide meaningful information for management, marketing, and research. Thus, efficient, accurate, and economic techniques will reduce the number of treatments, levels of residues, and risks to the operator and, consequently, better quality products will be obtained. Unbaited cylindrical plastic probe traps and grain sampling with a sieve were used to detect insects in stored wheat, in southern Brazil. The samples were taken from a large capacity silo, every fifteen days, during seven months. The total number of insects collected with the traps was significantly higher (21604 individuals) than that obtained by the grain-sampling (1326), at p = 0.01. However, relative efficiency and accuracy, besides the differences between the techniques, must be recognised when interpreting the data. Seven insect species were detected with the probe traps and six with the sieve. The flat and rusty grain beetles, *Cryptolestes* spp., were the most abundant species detected by both methods, representing 97.68% in the traps and 83.26% in grain sampling. Based on the occurrence and middle dominance of Palma (1975), only *Cryptolestes* spp. were classified as 'common' species (in the probe traps), while the others were either 'intermediate' or 'rare'. The lesser grain borer, *Rhyzopertha dominica*, and the rice and maize weevils, *Sitophilus* spp., were poorly collected by both methods due to their behaviour (distribution patterns and mobility). The main advantages of the probe traps over the sieve were: easier handling; continuous action, not requiring the constant presence of the operator; and detection of most species even at low infestation levels. The combination of the probe trap and the sieve data can give basic information about the species and their relative abundance for the stored-wheat management program in Brazil.

Introduction

A good insect sampling technique that is repetitive, accurate and less dependent on the operator is required for stored-grain pest management and marketing decisions, and also for research purposes. Based on a good monitoring program, control measures can be taken at the appropriate population level, reducing significantly the losses and costs.

It has been observed (Subramanyam and Harein 1989) that unbaited probe traps are more sensitive than grain sampling devices in detecting adults of various insect species in barley.

The number of insects captured in probe traps provides a relative measure of insect activity in grain, but does not estimate abundance of insects in the grain area sampled (Subramanyam et al. 1989). The number of adults captured in traps may vary depending on the insect species, trap duration, and grain temperature (Fargo et al. 1989; Subramanyam and Harein 1989; White et al. 1990).

The most common species caught in probe traps were the flat and rusty grain beetles, *Cryptolestes* spp., the red flour beetle, *Tribolium castaneum*, and the fungus feeder groups (Subramanyam and Harein 1989, 1990; White et al. 1990). Some species, such as the lesser grain borer, *Rhyzopertha dominica* and the maize and rice weevils *Sitophilus* spp. are not easily detected with probe traps, but, pheromones, escape-proof products, and other sampling devices may be combined with the probe trap technique to increase catches (White et al. 1990).

In planning a trapping program, one of the first considerations is the estimation of trap efficiency so that the number of insects caught can be converted to absolute insect density. Regression equations have been used (White et al. 1990) for calculating trap efficiency over a range of environmental conditions for several different stored-grain beetles. Also, trapping methods should be standardised and trapping data combined with grain-sample data for a more complete view of the kinds of insects that are present in the grain (White et al. 1990). Also, one must recognise the differences between techniques when comparing data.

The only stored-insect monitoring technique adopted in Brazil is the standard grain sampling sieve. Thus, the objective of this study was to compare the standard device to the probe trap technique to show the advantages of the traps for stored-wheat insect detection and for determining the relative occurrence and middle dominance of species.

Materials and Methods

The study was carried out in a silo in southern Brazil, with 1200 t of wheat from the 1991 crop. Twelve cylindrical probe traps, made with perforated plastic tubes of 30 cm long and 2.0 cm internal diameter, with 2.8 mm round holes sloping downwards (Subramanyam and Harein 1990; Subramanyam et al. 1989), were installed in the centre and periphery of the silo, according to the cardinal points, at a depth of 20.0 cm. The traps were checked every 15 days for seven months, and the insects removed and frozen for later counting and identification.

For grain sampling, a sieve 24.0 × 24.0 cm with 2.8 cm high edges and a mesh of 2.8 mm round holes, was used to take samples from about the same places and depth, and at the same dates as the probe traps. The insects obtained in the tray were taken to the laboratory for counting and identification.

A simple statistical variance analysis was applied to test the significance of the difference between the catches by the two methods.

The abundance of the specimens was related to the occurrence and middle dominance of species according to the criteria proposed by Palma (1975). The occurrence of each insect species was calculated by dividing the number of

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samples where a given species occurred by the total number of samples multiplied by 100. Thus:

0.0–25.0% = accidental species;
25.1–50.0% = accessory species;
50.1–100.0% = constant species.

The middle dominance was calculated dividing the number of individuals of a given species by the total number of individuals multiplied by 100. Thus:

0.0–2.5% = accidental species;
2.6–5.0% = accessory species;
5.1–100.0% = dominant species.

These two classifications were grouped into:

Common species
Constant and dominant.

Intermediate species
Constant and accessory;
Constant and accidental;
Accessory and accidental;
Accessory and dominant;
Accessory and accessory;
Dominant and accidental.

Rare species
Accidental and accidental.

Results

Table 1 presents the number of insects captured by the cylindrical probe traps and by the grain sample sieve during a period of 207 days. In all sampling days, the probe traps captured more insects (94%) than the sieve sampling (6%).

Table 2 shows, by the variance analysis between the two sampling methods, that the number of insects sampled with the probe traps was significantly higher (p=0.01) than the number of insects captured by the sieve.

The insect species collected with the traps and the sieve were about the same, but the occurrence of most species was higher in the probe traps (Table 3). Based on the occurrence and middle dominance, the species were categorised according to the Palma's classification, as shown on Table 3.

The flat and rusty grain beetles, *Cryptolestes* spp., were the most abundant species detected in both devices. They were considered 'common' species only in the probe traps, but 'intermediate' in the sieve. All other species were only 'intermediate' or 'rare' in both devices, by Palma's general classification (Table 3). Analysing the occurrence of the species, which represents the relative frequency of each species in the samples, it can be observed that *Cryptolestes* spp. were 'constant' (above 50.1%); *Typhaea stercorea*, the hairy fungus beetle, 'accessory' (25.1%–50.0%); and the others only 'accidental' (below 25.0%) in the traps. Using the sieve technique, *Cryptolestes* spp. and *Sitophilus* spp. were classified as 'constant' and all the others 'accidental'.

The middle dominance, which means the number of a given species related to the total number of individuals, showed differences for the same species when comparing both techniques (Table 3). In the probe traps, only *Cryptolestes* spp. were placed as 'dominant' species (above 5.1%), while all the others were 'accidental' (below 2.5%). The species of *Cryptolestes* and *Sitophilus* were 'dominant' in the sieve.

Table 2. Variance analysis comparing probe trap and sieve catches of insects in stored wheat.

Source of variation	DF	TS	AS	F
Methods	1	16957.928	16957.928	9.64**
Residue	22	36060.658	1639.121	
Total	23	53018.586		

**Significantly different at p=0.01.

Figure 1 shows the percentage of insects (total species) captured by the probe traps and sieve over the seven-month period. It can be noticed that the traps captured the insects in a consistent way, independent of the infestation level. The conventional sieving technique detected a noticable number of insects only when the infestation was relatively high.

Discussion

Insect sampling with probe traps was significantly superior to the standard grain-sieving technique: it proved to be easier to handle; it was more efficient in capturing stored-wheat insects either at high or low infestation levels; it captured a greater number of individuals of most species; the insects were captured alive and could be used for other research tests; and the continuous catching did not require the constant presence of the operator. However, the differences between the two techniques must be considered, because the traps were left inside the grain mass and removed only for recovering the insects, while the sieve was applied only during the grain sampling period.

The sieve method did not present consistent results; even during the periods of high infestation (as detected by the traps), the number of insects sampled was much less than that caught with the probe traps.

Pheromone baits can be placed inside the traps for detection of certain insect species, such as *R. dominica* and *Sitophilus* spp., which were, in this experiment, poorly collected with the probe traps, and a little more efficiently by the grain sieving.

It is known (Fargo et al. 1989; Subramanyam and Harein 1989; White et al. 1990) that the number of insects captured in the traps are related to species behaviour (aggregation, mobility), temperature, moisture, duration of trapping period, location, and number of traps, as well as insect density. Aggregation, low mobility, and probably low infestation levels could explain the low catches of *Rhyzopertha dominica*. On the other hand, *Sitophilus* spp. have high mobility and stay alive for long periods inside the chamber, thus they might climb and escape from the traps. The use of Fluon® or a killing agent in the collecting chamber can overcome the problem of *Sitophilus* spp. escaping from the traps (White et al. 1990). These species were also collected in low numbers in unbaited traps by other authors (Subramanyam and Harein

Table 1. Number of insects captured in stored wheat by probe traps and by grain sieving.

Methods	Sampling days										
	1	20	30	45	102	120	135	151	192	207	Total
Probe	250	160	45	107	38	193	3244	14352	856	2359	21604
traps (%)	97	83	47	63	79	89	98	97	80	84	94
Sieve	8	32	55	63	10	22	51	421	212	452	1326
(%)	3	17	53	37	21	11	2	3	20	16	6

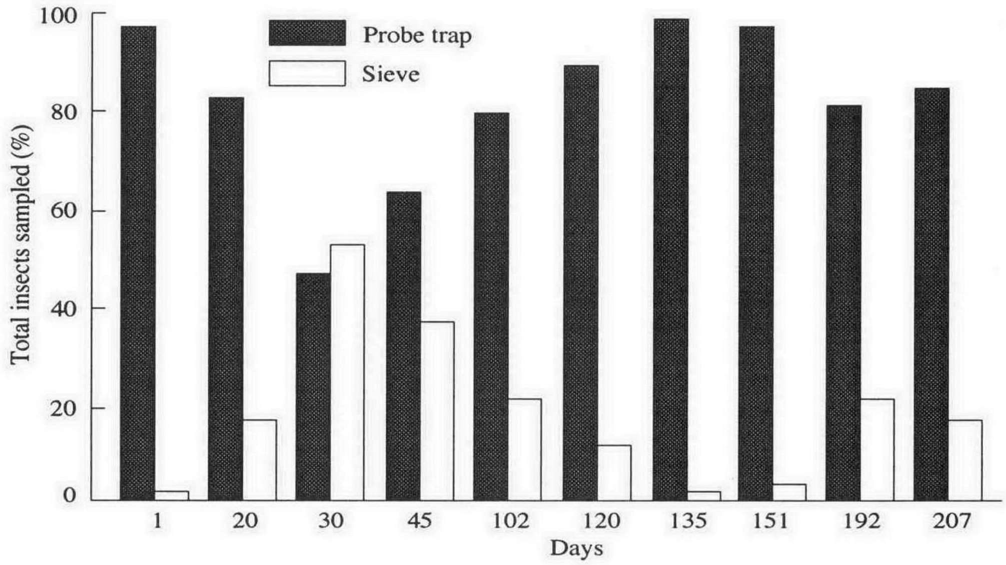

Fig. 1. Comparison between two methods for sampling stored wheat insects over 207 days.

Table 3. Total number of individuals, occurrence, middle dominance, and Palma's classification of insect species sampled with probe traps and sieve. (C = common, R = rare, I = intermediate).

Insect species	Probe trap				Sieve			
	Nº total individ.	Occurrence (%)	Middle domin.(%)	Palma's general classif.	Nº total individ.	Occurrence (%)	Middle domin.(%)	Palma's general classif.
Ahasverus advena (Col: Cucujidae)	25	9.2	0.12	R	53	5.8	3.99	I
Cryptolestes spp. (Col: Cucujidae)	21102	70.0	97.68	C	1104	40.0	83.26	I
Alphitobius spp. (Col: Tenebrionidae)	75	5.8	0.35	R	0	0.0	0.0	R
Tribolium castaneum (Col: Tenebrionidae)	9	4.2	0.04	R	1	0.8	0.08	R
Sitophilus spp. (Col: Curculionidae)	45	11.7	0.21	R	148	40.8	11.16	I
Rhyzopertha dominica (Col: Bostrichidae)	5	2.5	0.02	R	09	5.8	0.68	R
Typhaea stercorea (Col: Mycetophagidae)	343	29.2	1.58	I	11	3.3	0.83	R

1989; White et al. 1990), but pheromone lures proved to increase the catches.

In conclusion, despite the advantages of the probe traps, the use of data from the traps to estimate population density is difficult. However, insect catches can be converted to absolute insect densities by calculating trap efficiency for each species under a range of environmental conditions. The combination of probe trap and sieve data can give a more complete view of the insect species and their infestation levels in bulk-stored grain. Meaningful ecological information such as distribution, occurrence, abundance, dominance and diversity can be obtained by using the probe trap technique. Also, by the kind and relative numbers of the detected species, one can determine the conditions of storage and have a guide for management decisions. More studies are required in this subject, in Brazil.

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