Dynamics of insect populations in stored shelled corn (maize) treated with pirimiphos-methyl and thiabendazole

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Abstract

Insect samples were taken with probe traps at monthly intervals from grain bins containing shelled maize that had been treated with an insecticide (pirimiphos-methyl), a fungicide (thiabendazole), both pirimiphos-methyl and thiabendazole, or left untreated. Angoumois grain moth, *Sitotroga cerealella* (Olivier); hairy fungus beetle, *Typhaea stercorea* (L.); foreign grain beetle, *Ahasverus advena* (Waltl); and plaster beetle, *Cartodere constricta* (Gyllenhal) were the most abundant species during the first year of storage. In general, more insects were caught in control and thiabendazole-treated maize than in pirimiphos-methyl or pirimiphos-methyl +thiabendazole treated bins. Greater numbers of insects were caught at the centres than edges of grain masses. Similarly, more were caught at the surface of the grain masses than at the centre or base of the bulk.

Introduction

Infestations of stored grains by insect and fungal pests pose economic threats to farmers and commodity managers the world over. Infestation of grain by insects and fungi decreases its quality and marketability, and may lead to serious health hazards for human and livestock consumers.

Kentucky produces a substantial quantity of corn, currently storing 1.5 Mt (60 million bu) on the farm (Kentucky Agricultural statistics 1992). Distributions of insects within grain masses have been examined for bulk-stored wheat in Kansas (Hagstrum et al. 1985; Loschiavo 1983), bulk-stored barley in Minnesota (Subramanyam 1988), and a preliminary study of on-farm stored shelled corn in Kentucky (Sedlacek, unpublished data).

Information concerning the ecology of insects found in on-farm corrugated galvanised steel bins is lacking. Approximately 20 species of insects may inhabit stored corn and cause severe damage in the United States. These pests can decrease the quantity and quality of corn directly and indirectly. Therefore, efficiently sampling insects, knowing seasonal abundance and distribution patterns, and determining the effects of pesticide application require investigation. The objective of this research was to examine insect population dynamics in on-farm stored shelled corn that had been treated with an insecticide, a fungicide, both pesticides, or neither.

Materials and Methods

Approximately 15 ha of 'DeKalb 689', a corn hybrid commonly grown in central Kentucky, was planted in mid-May 1989. The crop was harvested at approximately 20% moisture content in early November. At the time of binning, one-fourth of the crop was treated with thiabendazole at the recommended rate of 0.12 litres per 100 bu of corn, one-fourth was treated with pirimiphos-methyl at the recommended rate of 0.36 litres per 1000 bu of corn, and one-fourth was treated with thiabendazole + pirimiphos-methyl. The remainder was left untreated and served as controls.

Approximately 250 bu of treated/untreated corn was loaded into each of 12300 bu bins. A randomised complete block design was used as the experimental design. Nine probe traps were set in each bin after loading in order to capture insects. The traps were set at three depths (1.8 m, 0.9 m, and 0.3 m or surface locations) 0.2 m from the north and south walls of the bin and directly in the centre of the grain column. Contents of the traps were emptied into labelled vials containing 70% ETOH once per month during the sampling year. Traps were reset immediately following this procedure. Insects were removed from crop debris, identified with appropriate taxonomic keys, and quantified.

Results and Discussion

Eleven species of pest insects, nine Coleoptera and two Lepidoptera, were caught during the storage year. However, only four species appeared in significant numbers. The Angoumois grain moth, *Sitotroga cerealella* (Olivier), hairy fungus beetle, *Typhaea stercorea* (L.); foreign grain beetle, *Ahasverus advena* (Waltl); and plaster beetle, *Cartodere constricta* (Gyllenhal) were the dominant species during this time. The hairy fungus beetle was the single most abundant species. In July, 21% of the population of insects was composed of the hairy fungus beetle while only one month later, >83% of the population was composed of this species. Thus, species composition apparently can change dramatically from month to month.

Densities of the Angoumois grain moth began to increase in May, while those of hairy fungus beetle, foreign grain beetle, plaster beetle, and total insects began to increase in July. The increase in insect density roughly coincided with warming of the grain masses in spring and early summer. As the temperature of the corn increased, so did the development and activity of insects and, thus, the number caught in traps. Moisture content of grain has a profound effect on the kinds and numbers of insects present as well. Storey et al. (1983) found that moisture changes as low as 0.5% alters densities. Based on data currently available (September samples have yet to be completely analysed) the apparent peak densities for control, thiabendazole, and pirimiphos-methyl + thiabendazole-treated corn were in August. Peak densities of insects in pirimiphos-methyl-treated corn was during October. Preliminary counts, however, indicate it is likely that the observed peak densities for total insects in all treatments will be during September.

In general, control and thiabendazole-treated corn had greater numbers of Angoumois grain moth, hairy fungus beetle, foreign grain beetle, plaster beetle, and total insects than pirimiphos-methyl or pirimiphos-methyl + thiabenda-

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Table 1. Effect of pesticide treatment on densities of insects in on-farm stored corn. Values presented are yearly averages per treatment.

Treatment	Species				
	Sitotroga cerealella	*Typhaea stercorea*	*Ahasverus advena*	*Cartodere constricta*	Total insects
Control	0.7 ± 0.3	17.9 ± 10.9	2.2 ± 1.4	0.8 ± 0.6	22.3 ±12.6
Thiabendazole	1.1 ± 0.5	23.4 ± 13.5	2.8 ± 1.5	1.1 ± 0.8	29.5 ±15.3
Pirimiphos-methyl	0.5 ± 0.3	17.3 ± 1.5	2.3 ± 1.5	0.1 ± 0.1	22.4 ± 13.9
Pirimiphos-methyl +Thiabendazole	0.3 ± 0.2	11.6 ± 7.6	1.2 ± 1.5	0.1 ± 0.0	13.4 ± 8.6

zole-treated corn (Table 1). Densities of hairy fungus beetle, foreign grain beetle, and plaster beetle were lowest in the pirimiphos-methyl + thiabendazole- treated corn. This is to be expected for these insects because they are fungivores and should be affected directly by pirimiphos-methyl and indirectly by thiabendazole reducing potential food sources (fungi). The overall efficacy of pirimiphos-methyl by itself, based upon yearly averages of counts, was disappointingly low.

Greater numbers of insects were generally caught in the centres than edges of the grain masses (Table 2). Likewise, more insects were apparently caught at the tops of grain masses than the centres or bottoms of grain masses. These results are similar to those of Hagstrum et al. (1985) who found that the distribution pattern of insects differed among species found in bulk-stored wheat. They found that densities of the five most abundant species and total insects were higher in the centre of the grain mass than elsewhere. Information such as this is useful when sampling stored grain in order to detect or estimate insect populations because it enables early detection of pests and increases the efficiency in deployment of sampling devices. This in turn will permit more practical, economical and accurate management decisions to be made.

Table 2. Effect of direction and depth on numbers of insects caught during August 1990.

Species	Trap location					
	Direction	N	Mean ± SE	Depth(m)	N	Mean ± SE
Sitotroga cerealella	Centre	36	0.6 ± 0.2	0.3	36	4.9 ± 2.6
	North	36	1.4 ± 0.8	0.9	36	0.6 ± 0.2
	South	36	4.1 ± 2.5	1.8	36	0.7 ± 0.3
Typhaea stercorea	Centre	36	164.5 ±40.3	0.3	36	171.8 ±44.6
	North	36	100.2 ±23.9	0.9	36	62.1 ±12.8
	South	36	28.6 ± 6.0	1.8	36	59.3 ±10.1
Cartodere constricta	Centre	36	1.4 ± 0.4	0.3	36	0.7 ± 0.3
	North	36	1.0 ± 0.3	0.9	36	0.7 ± 0.2
	South	36	0.1 ± 0.0	1.8	36	1.1 ± 0.4
Ahasverus advena	Centre	36	16.3 ± 6.1	0.3	36	17.6 ± 7.2
	North	36	14.5 ± 4.4	0.9	36	9.4 ± 2.2
	South	36	5.5 ± 1.4	1.8	36	9.4 ± 1.7
Total Insects	Centre	36	185.8 ±45.7	0.3	36	197.8 ±49.7
	North	36	119.2 ±25.0	0.9	36	74.4 ±13.6
	South	36	39.9 ± 7.6	1.8	36	73.0 ±11.2

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