PERFORMANCE AND GROWER ACCEPTANCE OF PROBE-PITFALL TRAPS USED TO MONITOR COLEOPTRA THAT INFEST FARM-STORED CORN IN NORTHEASTERN NORTH CAROLINA

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ABSTRACT

Commercially available probe-pitfall traps baited with an experimental aggregation pheromone, sitophinone, captured from 2 to 6 times more *Sitophilus*, *Tribolium*, and *Cryptolestes* in farm bins of stored corn than did similar traps without this pheromone. *Stegobium* captures were about equal. All traps, baited or not, detected pest insects earlier and with more precision than did samples taken with a 6-ft. (1.8 m) compartmentalized grain trier or with a cup-sampler at 1, 2.5 and 4 meter depths. Indianmeal moth larvae invading those probe-pitfall traps placed near the grain surface necessitated placement to at least arm's length depth to prevent webbing and subsequent clogging of the traps. Probe-pitfall traps at 1 meter depth captured more *Tribolium*, while those at 4 meters captured slightly more *Sitophilus*.

INTRODUCTION

Probe-pitfall traps to monitor stored-grain insects have been developed and used by several researchers under laboratory and field conditions (Loschiavo, 1975; Loschiavo and Atkinson, 1973; Loschiavo *et al.*, 1986; Barak and Harein, 1982; Lippert and Hagschum, 1987). Pheromones active on several species of *Sitophilus* have also been studied, largely under laboratory conditions (Phillips *et al.*, 1985; Walgenbach *et al.*, 1983; and Walgenbach and Burkholder, 1986).

This study was done to test the effectiveness of probe-pitfall traps with and without sitophinone, a synthetic aggregarion pheromone for *Sitophilus* to monitor insects in farm-stored corn in northeastern North Carolina from November 1986 until July 1987. A subsequent study in 1988-89, using similar techniques, ascertained potential farmer acceptance of a pilot stored-grain IPM program operated by a local cooperative.

METHODS AND MATERIALS

1986-87 Study

One grain bin on each of twelve farms in four neighboring northeastern North Carolina counties was used in this study. The bins were typical circular metal structures in reasonably good repair and ranged from approximately 5,000 to 20,000 bushel capacity. The study began in October 1986 and continued until the corn was sold or until July 1987, whichever occurred first. I sampled a single bin monthly on each of three farms in each of the four counties for a total of 12 bins.

Two commercially available (Grain Guard, Inc., Verona, WI) Lexan probe-pitfall traps, 2.5 cm diam and 36 cm long, one containing a rubber septa with 100 micrograms of sitophinone, the other a septa with carrier but no pheromone, were inserted ca. 1 meter apart to arm's length in the grain near the center top of each bin in October 1986. Usually, this area contained the greatest proportion of fines and presumably was most likely to yield the greatest number of insects. Each month the samples were removed and the traps reinserted to their approximate former position. Fresh septa, half with pheromone, half without, were reinserted in each trap in April 1987 as the grain temperature and insect activity increased after the dormant winter period. At each sampling, a temperature reading was also taken approximately midway between the traps at arm's length into the grain.

To compare the efficiency and precision between probe-pitfall traps and conventional grain trier sampling procedures, five vertical grain samples evenly spaced across the top of the grain in a N-S transect were taken monthly with a 1.8 m compartmentalized grain trier and combined into one composite bin sample of approximately 2 kg. All insects in this composite sample, living or dead, were counted within 2 days after collection by passing the grain through a 12/64" round (commercial) grain dockage sieve (Burrows, Evanston, IL).

1988-89 Study

Arrangements were made with a local IPM cooperative to offer no-cost scouting services and pest control advice to a pilot group of 10 farmers in the four counties involved in the previous study. Seven of these had been involved in the earlier study.

Two probe-pitfall traps without pheromone but equipped with temperature-sensitive strips were inserted into the grain at one and three meter depths respectively to ascertain any differences of insect captures at these two depths, particularly in reference to *Sitophilus* weevils. Where possible, the bin was entered and the traps inserted vertically ca. one-third of the distance between the bin center and the side wall in line with the manhole entrance in the bin roof. This approximated the outer edge of fines in most bins and presumably should yield a reasonable number of insects without excessive trap contamination by cracked kernels and similar debris. In cases where the bins were filled into the roof area and entrance by the scouts was impossible, the traps were inserted either through the side roof manhole or the center roof opening, whichever was most practical. Grain samples were also taken with a deep-bin cup sampler @ ca. one, 2.5 and five meters depth and checked for moisture and live insects using the grain dockage sieve mentioned above.

The sampling interval was tied to approximate ambient temperatures for the period. Weekly sampling was done above 60 degrees F (15 C), biweekly sampling when temperatures ranged from 50 F (10 C) to 60 F (15 C) and monthly sampling was done below 50 F (10 C). These temperatures approximate, respectively, the lower thresholds of reproduction, feeding, and relative inactivity by stored product insects and were chosen to

optimize cost with adequate sampling necessary to alert growers of potential pest problems.

RESULTS AND DISCUSSION

1986-87 Study

Probe-pitfall traps baited with pheromone collected more *Sitophilus*, *Tribolium*, (all appeared to be *castaneum*) and *Cryptolestes* (mostly *ferrugineus* but also a few *pusillus*), while approximately equal numbers of *Stegobium paniceum* were captured by baited and unbaited traps alike. Either probe-pitfall trap was superior to the compartmentalized grain trier.

NUMBERS OF INSECTS

PITFALL TRAPS

	W/PHER.	W/O PHER	P	GRAIN TRIER
SITOPHILUS	36	10	0.06	3
TRIBOLIUM	4032	2832	0.10	91
STEGOBIUM	520	553	0.43	4
CRYPTOLESTES	383	150	0.11	9

Sitophilus were captured in low numbers on only 3 of the 12 farms that I sampled, and all 3 were in the same county (Pasquotank). The first 3 weevils were detected by probe-pitfall traps in November on 2 farms. Two of these were captured in 2 unbaited traps, the other was found in one baited with sitophinone. In December, the baited pitfall-traps outperformed the unbaited traps ca. four-fold on both farms, and one weevil was finally detected on one of these farms in a trier sample.

In March of the following year, a baited probe-pitfall trap detected weevils on one of the farms that had been infested in 1986. In May, additional weevils were captured on this farm and on two additional farms, one of which had shown infestation in 1986. Additional weevils were captured by both baited and unbaited traps in June and July, and two weevils were finally detected by a trier sample on one of these farms in late June. Baited traps outperformed unbaited ones ca. four-fold during the spring sampling period. Paired "T" analysis of the Pasquotank County data showed a probability of 0.0643 difference between baited and nonbaited pitfall traps.

ANOV analysis indicated a probability difference of .0641 between grain trier and probe-pitall samples. Since this genus has tremendous potential for damaging stored grain, early detection is of utmost importance if timely control efforts are to be implemented by growers or storage facility personnel. Taking into consideration the low infestation levels, it is quite clear from this data that traps baited with sitophinone were far more sensitive than unbaited traps and that either were more precise than trier samples in detecting time and severity of *Sitophilus* infestations.

The most numerous insects captured by the probe-pitfall traps were red flour beetles, *Tribolium castaneum*. This is partially due to the wide use of malathion as a grain protectant, to which these beetles are resistant. These beetles were present in 9 out of the 12 farms included in the study. Only the farms in Camden County contained none (in fact Camden County samples contained NO beetles of any kind for the duration of the study, and data from Camden were not used in any of the following statistical analyses). On several occasions, the traps were completely full of these insects in various stages of decay. Obviously, the sampling interval of one month was too long when large numbers of this insect were encountered.

While the traps with pheromone captured more total *Tribolium* than those without, performance was quite variable and differences were not statistically significant ($P = 0.1$). While these beetles were captured in almost every month of the study, as expected, far greater numbers were captured during the months when grain temperatures were highest, especially in the fall months. Baited or nonbaited probe-pitfall traps were more precise than the trier samples, ($P = 0.06$) although at higher infestation levels the trier was reasonably predictive. The trier failed to detect *Tribolium* presence on 3 occasions when samples were found in the probe-pitfall traps. On no occasion did the inverse occur. It would appear that sitiphinone has little attractiveness to *Tribolium* under these conditions. Obviously, probe-pitfall traps with no pheromone worked quite well.

Large numbers of drugstore beetles, *Stegobium paniceum* were captured by probe-pitfall traps, especially during the warmer fall months. Infestations of this insect appeared to largely die out during the winter and did not reappear until late June 1987 and then only on one farm. Captures were quite variable between baited and unbaited traps and no significant differences were noted ($P = 0.43$). It appears, therefore, that sitophenone has no effect upon drugstore beetles.

Grain trier samples collected very few of these beetles, and this method appears to be a poor method for detecting these insects under moderate to low infestation levels. ANOV analysis indicated a $P = 0.0161$ difference between trier and probe-pitfall trap samples for this insect, indicating the superiority of the probe-pitfall trap.

Cryptolestes spp., mostly *C. ferrugineus*, the rusty grain beetle, were captured in sizable numbers throughout the study. This genus usually

indicates grain of high moisture, which is surprising since very little mold, crusting or mustiness was noted in any of this corn. Most farmers had used heat drying and most had tested the grain for moisture before binning or before cessation of aeration. Although the baited traps captured about twice as many *Cryptolestes* than unbaited, numbers were highly inconsistent and no statistical significance was found (P = 0.11). It appears, therefore, that sitophenone has little, if any, attractiveness to this genus. Significant difference (P = 0.03) was noted between trier and probe-pitfall trap samples, again indicating pitfall trap superiority.

DISCUSSION

The monthly sampling interval clearly was too long for many of the pitfall trap samples. In some instances, particularly with high numbers of *Tribolium*, the traps became full and insects putrefied before collection. Monthly sampling also negates any advantage of early detection, which is of utmost importance, especially with the internal-feeding insects. A weekly sampling schedule should be satisfactory during warm months, with biweekly and maybe monthly collections probably sufficient during cooler periods for most situations.

Clogging of the pitfall traps with Indianmeal moth larval webbing presented a serious problem when the traps were only placed level with the grain surface or inserted only "fist deep." Pushing the traps as far as possible up to arm's length into the grain largely solved that problem. A shorter sampling interval would also help.

While the above data summarize the most numerous insects caught, a wide variety of other insects were occasionally captured. These included *Carpophilus* (various sap beetles), *Typhaea stercorea* the hairy fungus beetle, *Ahasuerus advena*, the foreign grain beetle, and occasional Hemiptera, Hymenoptera, and other insignificant beetle families.

Grain temperatures varied greatly, depending on the aeration management practiced by each individual grower. The best manager maintained the grain temperature below 15 degrees C from November through May, while the worst maintained this level from only January through March. At this temperature, most stored grain insects cease reproduction and at 10 degrees cease feeding. Obviously, much better aeration management must be promoted to gain the pest control advantages of this practice. Cold air is the cheapest stored grain insect control substance available to North Carolina farmers, and most are not using it properly!

1988-89 IPM Study

RESULTS

Of 122 probe-pitfall trap samples, only 13 contained insects. Nine samples contained red flour beetles, *Tribolium castaneum*, six were from one meter depth, the other three from the traps at four meters. Only two samples, both from the same farm, contained maize weevils, *Sitophilus zaemais*. Both were at the four meter depth, one sample being taken in November, the other December 1988. These samples plus one more in January

taken from the same farm also contained foreign grain and hairy fungus beetles. Of the ten farmers who participated, five had no insects in their probe-pitfall traps.

The deep-bin cup samples were much less precise than the probe-pitfall traps in detecting insects in grain. On only two occasions on succeeding weeks on one farm were any insects detected by the cup sampler. On December 1, 1988, over 200 red flour beetles were captured in a probe-pitfall trap at four meters deep, while only 7 were captured in the deep bin cup at five meters. On December 8, over 100 were captured in the same probe-pitfall trap while only one was detected in the comparable cup sample. All other cup samples were negative.

Observations by scouts while sampling indicated slight to moderate Indianmeal moth infestations at all farms. In most cases, the infestations reached their peak in late November and were eliminated by cold weather in December and January. In no case was any economic damage noted from IMM attack.

Moisture samples varied from 11.6 to 13.8% with most falling between 12.0 and 12.5%. Not surprisingly, the 13.8 readings coincided with the two pitfall samples that contained the foreign grain and hairy fungus beetle samples. Most farmers in this area of North Carolina harvest their grain early to escape potential hurricane damage and then heat dry the grain before storage. Temperature readings closely approximated those reported in the earlier study.

DISCUSSION

It is quite obvious that probe-pitfall traps are much more precise than either compartmentalized grain triers or deep bin cup samplers in detecting potential Coleopterous insect pests in farm grain storage. They are easy to use, economical to purchase and potentially very useful in detecting insect problems before they reach major proportions. Unneccesary prophylactic fumigations could virtually be eliminated if these devices were in widespread use on farms. Continued studies of an expanded nature most likely would show statistical difference of *Sitophilus* captures between pitfall traps with and without sitophinone, although traps with or without pheromone were much more sensitive than either grain trier or cup samplers.

Unfortunately, North Carolina farmers generally do not place a high priority on grain sampling and prefer to simply fumigate before shipping their grain or else just take their chances at the mill or elevator. None of the ten farmers involved in the IPM study felt it of sufficient value to continue for another year on a cost-sharing basis.

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PERFORMANCES DES PIEGES UTILISES POUR SURVEILLER LES COLEOPTERES RAVAGEURS DU MAIS STOCKE A LA FERME DANS LE NORD-EST DE LA CAROLINE DU SUD ET LA REACTION DES FERMIERS A LEUR UTILISATION.

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RESUME

Des pièges trappes-entonnoirs disponibles dans le commerce et appâtés avec une phéromone d'agrégation expérimentale, la Sitophinone, ont capturé de 2 à 6 fois plus de *Sitophilus, Tribolium,* et de *Crytolestes* dans les cellules à maïs que n'ont capturé des pièges semblables sans phéromone. Tous les pièges, appâtés ou non, ont permis de détecter les ravageurs plus précocement que l'examen d'échantillons prélevés à la sonde à compartiment de 6 pieds (1,8 m). Les chenilles de la pyrale des fruits secs ont envahi ces pièges disposés à la surface du grain, et il a fallu les placer au moins à une longueur de bras au-dessous de la surface pour éviter qu'ils ne soient recouverts par la toile tissée par les chenilles et risquant ainsi de les boucher.

Des pièges sans appât surveillés par des éclaireurs (boyscouts) employés par une coopérative IPM régionale ont prouvé la commodité d'utilisation de ces pièges lors d'un programme d'inspection systématique des cellules. Malheureusement, étant donné que le stockage du grain est une activité secondaire dans les fermes de Caroline du nord, les fermiers n'ont pas voulu financer les recherches.