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A new trap model to increase the trapping of *Cryptolestes ferrugineus* (Coleoptera: Laemophloeidae) in wheat filled containers

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Abstract : A two in one model trap was designed by combining the features of TNAU probe and pit fall traps to trap the rusty grain beetle, *Cryptolestes ferrugineus* in stored grain. The efficiency of the new model was studied in comparison with the probe and pit fall traps and found that significantly more beetles were caught in newly designed one. Trapped beetles were more at 28°C within the trap models. We hope that the proposed model will be more effective to predict the potential migrants early so that, further multiplication in storage can be prevented. This two in one model trap can capture the *C. ferrugineus* adults both under normal temperature conditions (while beetles are moving downward) and during winter (while moving towards the central core of granaries) which are the two important situations, the wheat filled granaries in North America face with *C. ferrugineus* distribution.

Introduction

Cryptolestes ferrugineus (Stephens) (Coleoptera: Laemophloeidae) commonly known as the rusty grain beetle occurs frequently and widespread in North America (Barak and Harein, 1981; Hagstrum *et al.,* 1994). Its presence in stored grain results in price discount at the point of sale. Monitoring adult *C. ferrugineus* population using probe-pit fall traps is well documented (Loschiavo, 1974; White and Loschiavo, 1986; Subramanyam and Harein, 1990). However, there are many interacting factors that affect the performance of these traps among which trap design is one of the most important factors.

Currently, there are two trap models in use for monitoring insects in North American grain storage conditions. They are WBII probe trap (Storegard WBII, Trece Inc. Salinas, CA) (Burkholder, 1990) and PC pitfall trap (Agrisense BSC Limited, Pontypridd, Mid Glamorgan, UK) (Cogan *et al.,* 1990). Recent studies by Toews *et al.* (2003) indicated that WB II trap captured significantly fewer *C. ferrugineus* compared to PC traps, though WBII trap is widely recommended under North American grain storage conditions for early detection of C. *ferrugineus* in steel bins especially in wheat and barley. Further, the PC trap being a cone shaped trap needs coating its inner surface of pitfall cone with sticky materials (Tangle foot) to hold the trapped insects making this procedure tedious.

Hence, we have developed a new trap model keeping in mind the behaviour and distribution patterns of *C.ferrugineus* as suggested by earlier workers. Geotactic behaviour, increased detection in grains of uniform moisture content, vertical movement in grain, mass depending on grain temperature, overcoming of positive geotactic behaviour after 24 hours of migration into grain are some of the key factors we considered while developing the new model (Loschiavo, 1983; White and

Table 1. Percentage *Cryptolestes ferrugineus* trapped in various trap models.

Sl.No.	Trap model	Percentage insects trapped		
		28°C	12°C	7°C
1.	Two in one model trap (new model)	58.5^{Aa}	40.5^{Ab}	33.5^{Ab}
2.	TNAU pitfall trap	55.8^{Ba}	34.0 ^{Bb}	22.5^{Bb}
3.	TNAU probe trap	2.8^{Ca}	1.8^{Cb}	0.5^{Cb}

Values are means of four replications.

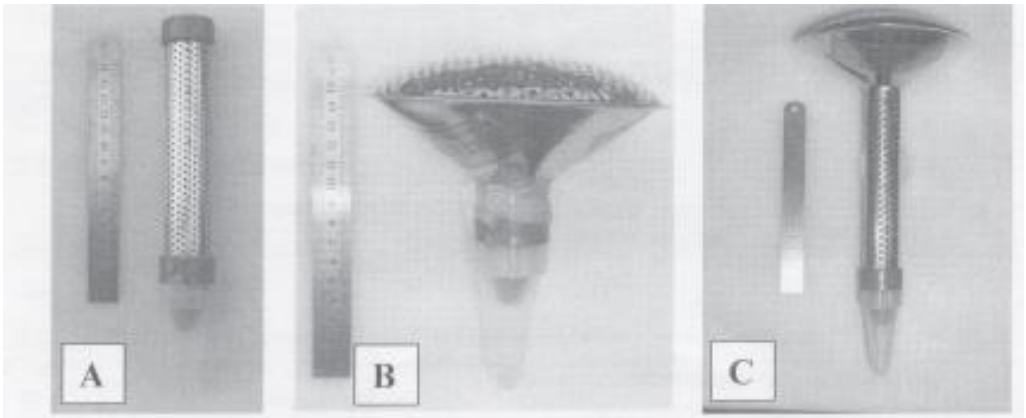

Fig. 1. Types of stored-grain insect trap: TNAU probe trap (A), TNAU pit fall trap (B), and Two in one model trap (new model) (C). The ruler in each photograph is 15 cm long.

Loschiavo, 1986; Toews *et al.,* 2003; Jian *et al.,* 2004).

Materials and Methods

New trap model and testing

The proposed model combines the probe and pit fall trap units with the cone shaped nature of PC trap thus, it is a two in one model trap. It has a cone shaped top portion which has carefully sized holes (3 mm) to allow the entry of the insects, with the bottom of the cone tapering into a probe pit fall trap tube which also has equi-spaced 3 mm perforations on the tube (Fig. 1). The new model trap contains approximately 910 holes of 3 mm diameter.

One more advantage here is, it does not require tedious procedures like coating the inner surface of pitfall cone with sticky

materials. Similar type of trap has been developed and used in India for *Callosobruchus chinensis* which attacks leguminous seeds (Mohan *et al.,* 2004).

Testing

The efficiency of the new model was studied in the laboratory in comparison with the standard TNAU probe trap and TNAU pit fall trap (PC type) (Mohan *et al.,* 2004) in which the bottom cone tapers into funnel shaped trapping tube thus dispensing with application of special coating with sticky material to hold the trapped insects which is followed in PC type trap (Fig. 1). The TNAU probe trap has approximately 667 holes of 2mm diameter while TNAU pitfall trap has 408 holes of 3 mm diameter. The efficiency of the new trap model in comparison with the other two standard type traps was studied by placing them just below the surface of wheat (13% moisture content), filled in cylindrical containers of 280 mm height and 210 mm diameter which can hold 4.5 kilograms of wheat (Loschiavo, 1974 and Toews *et al.,* 2003).

One hundred numbers of laboratory reared unsexed *C. ferrugineus* adults were released by sprinkling them over the surface of wheat in cylinders. Traps were examined after 24 hours (Loschiavo, 1974). The experiment was conducted at three temperatures i.e., 28°C, 12°C and 7°C, as grain temperature is known to influence the trap catch. There were four replicates per treatment. RH of 65±5% was maintained uniformly for all trials.

Statistical analysis

The data pertaining to the observation in the laboratory were transformed using the inverse sine transformation and then analyzed using two way ANOVA with Duncans Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

Results of the present study showed that significantly more beetles were caught in trap of new design (Table. 1) followed by TNAU pitfall trap and TNAU probe trap at all the tested temperatures.

In a column, means followed by the same letter (upper case) and in a row means followed by the same letter (lower case) are not significantly different by Duncan's Multiple Range Test (P=0.05).

However within the trap models, catch was significantly more only at 28°C. Grain temperature is one of the most influencing factors on trap catch and biological activity of *C. ferrugineus* is more around 27 - 30°C (Jian, 2004). Further, *C. ferrugineus* being active fliers migrate into the bins that have an opening in any area. From the results of Toews *et al.* (2003), we believe that the presence and multiplication *of C.ferrugineus* in the grain stored in bin was a result of migration of the beetles through the top inlet as well as the aeration duct beneath the perforated floor of granary. Entry through aeration duct can be prevented by application of sticky material at the hopper bottom beneath the floor leaving the top inlet (head space) alone as a possible source of entry for the migrant beetles. It is very important to predict these potential migrants early as they land on grain surface so that further multiplication in storage can be prevented (Flinn *et al.,* 1997). Hence, we hope the proposed model will be more effective in this regard as a reliable decision support tool.

We also hope that the proposed new two in one model design will surely address the two important situations, the wheat filled granaries in North America face with *C. ferrugineus* distribution i.e., during early

period of storage, downward movement of *C. ferrugineus* adults in uniform moisture and normal temperature conditions (28°C to 30°C), may facilitate capture by the cone shaped portion (horizontal plane) besides the vertical probe trap portion and during winter, when beetles move towards the central core of granaries it may result in capture by the vertical portion of the new two in one trap model.

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