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# Development of a trap for monitoring *Tribolium* spp. and evaluation of the activity with different baits[1]

**Abstract** - Based on the results of a previous study, that compared different type of traps sold on the market, the characteristics that can improve a trap for flour beetles were delineated. On the basis of this research four black traps were produced. The prototype of the trap, that showed the best catching activity, was activated with different attractants present on the market, in order to evaluate the effectiveness of trapping *Tribolium castaneum* and *T. confusum*. The trap had the shape of a truncated pyramid with squared basis and a rounded central pitfall with perpendicular walls. Externally the trap was made of flocked PVC, while the top and the pitfall were made of smooth PVC. The substances used to bait the trap were: food attractant (cellulose disk imbued with 200$\mu$l of wheat germ oil), standard dispenser (natural rubber) and disk dispenser (expanded rubber) lured with 1 mg of 4,8-dimethyldecanal, provided by Novapher, Pest Patrol (89.62% wheat germ oil, 9.96% inactive ingredients, 0.42% 4,8-dimethyldecanal), wheat germ oil, and carob water extract. Tests were carried out in plastic arenas (40x60cm) in a thermostatic chamber at 26±1°C and 70±5% r.h.
The most attractant substances for the two species were Pest Patrol and 1 mg of 4,8-dimethyldecanal in standard dispenser and disk dispenser. Wheat germ oil showed the same attractiveness of the pheromone for *T. castaneum*, while for *T. confusum* it showed the same poor activity of the food attractant. Carob water extract showed a poor attractiveness for both the species.
The number of adults caught by the trap gradually increased with the time, but significative differences were not observed among the number observed at 24, 48, 72 hours except for the number of *T. castaneum* with the carob water extract.

**Riassunto** - *Progettazione di una trappola per il monitoraggio di* Tribolium *spp. e valutazione dell'attività di cattura con diverse sostanze attrattive*

Dai risultati di precedenti ricerche, in cui sono state confrontate diverse trappole per Triboli in commercio, sono state delineate le caratteristiche che possono rendere più efficiente una trappola per Triboli. In base a questi studi sono state preparate quattro trappole di colore nero. Il prototipo che ha mostrato la migliore capacità di cattura è

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a forma di piramide tronca a base quadrata e pozzetto centrale circolare con pareti perpendicolari. Per la parte esterna della trappola è stato utilizzato PVC flocculato, mentre per la sommità e il pozzetto è stato utilizzato PVC liscio. E' stato attivato con diverse sostanze attrattive presenti sul mercato: fagoattrattivo (dischetto di cellulosa con 200$\mu$l di olio di germe di grano), 1 mg di feromone (4,8-dimetildecanale), su erogatore standard (gomma naturale) ed erogatore a dischetto (gomma espansa) forniti da Novapher, Pest Patrol (89,62% olio di germe di grano, 9,96% sostanze inerti, 0,42% 4,8-dimetildecanale), olio di germe di grano, estratto acquoso di carruba. I test sono stati effettuati all'interno di arene in plastica (40x60cm) in ambiente termostatato a 26±1 °C e U.R. 70±5%.
Le sostanze maggiormente attrattive per entrambe le specie sono risultate Pest Patrol e il feromone (4,8-dimetildecanale) in entrambi gli erogatori. L'olio di germe di grano è risultato efficace al pari degli attrattivi a base di feromone nel caso di *Tribolium castaneum*, ma non per *T. confusum*. L'estratto di carruba si è dimostrato poco efficiente per entrambe le specie. Il numero di adulti catturati dalla trappola aumenta gradualmente nel tempo ma non si rileva una differenza significativa fra le catture a 24, 48 e 72 ore, tranne che nel caso dell'estratto acquoso di carruba per *T. castaneum*.

**Key words**: Red flour beetle, Confused flour beetle, trap, bait, monitoring.

## INTRODUCTION

Pheromone traps efficiently monitor moths in food warehouses and food departments, and they help in timing pests treatments, whereas beetle traps provide less reliable information on infestation size. Several authors reported on development of traps for flour beetles (De Coursey, 1931; Suzuki & Sugawara, 1979; Suzuki & Mori, 1983; Suzuki *et al.*, 1984; Javer *et al.*, 1990; Mullen, 1992; Trematerra, 1993; Athanassiou *et al.*, 2006). Direct observations showed that the number of individuals caught by flour beetles traps do not correspond to the real infestation observed by inspecting foci of infestation. Locatelli *et al.* (2005) observed that the poor efficiency of traps for *Tribolium confusum* (Herbst), currently on the market in Italy, was mainly caused by the shape of the trap. Insects have often difficulty in entering the traps as materials used are slippery or because traps have a steep entry. Subsequent studies confirmed the movement difficulty of *Tribolium castaneum* J. du Val and *T. confusum* on different materials even when placed horizontally (Limonta & Locatelli, 2007). In a previous research, Limonta *et al.* (2008) identified the material that is more suitable for flour beetle traps, as flocked polyvinyl chloride (PVC). On flocked PVC flour beetles walked nimbly, regardless of slope. *T. castaneum* is more attracted by 4,8-dimethyldecanal when reared on poor food and both sex are equally attracted (Fedina & Lewis 2007).

In this research a prototype of a trap was prepared and activated with different attractants present on the market, in order to evaluate the effectiveness of trapping *T. castaneum* and *T. confusum*.

## MATERIALS AND METHODS

The adults of *Tribolium castaneum* and of *T. confusum* used in the tests were reared in glass jars (2L) containing soft wheat flour (50%) and wheat bran (50%) at 26±1 °C and 70±5% r.h.

Tests were carried out in plastic arenas (40x60cm) the bottom of which was coated with paper in order to avoid electrostatic effects, in a thermostatic chamber at 26±1 °C and 70±5% r.h. Arenas were placed under shelves in order to simulate the conditions of aeration and light found under machineries in food departments. The number of adults caught by the trap was checked after 24, 48 and 72 hours.

### *Development of the trap*

In a previous study (Locatelli *et al.* 2005), that compared different type of traps sold on the market, the characteristics, that can improve a trap for flour beetles, were delineated. On the basis of this research four black traps were produced (figs. 1-2): two (squared) in the shape of a truncated pyramid with squared basis (bottom base 12cm, top base 4cm, height 2cm, slant with an angle of 30°) and a rounded central pitfall (diameter 3.5cm) with perpendicular (cylindric) or inclinate (conic) walls (60°); two (rounded) in the shape of a truncated cone, (diameter 12cm, height 2cm, angles 30°) and a rounded central pitfall (diameter 3.5 cm) with perpendicular (cylindric) or inclinate (conic) walls (60°). The slants must be rough in order to allow insects climbing. On the contrary, the walls of the pitfall must be smooth in order to allow the flour beetles to fall inside. Externally the trap was made of flocked PVC, while the top and the pitfall were of smooth PVC.

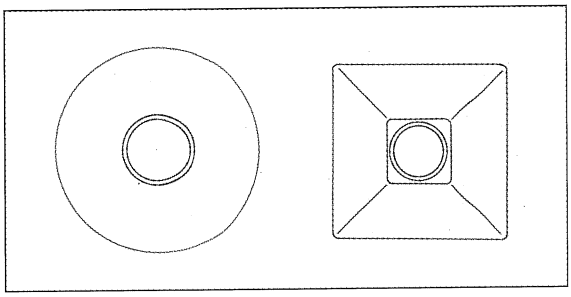

Fig. 1 - Bird's eye view on the rounded and the squared traps.

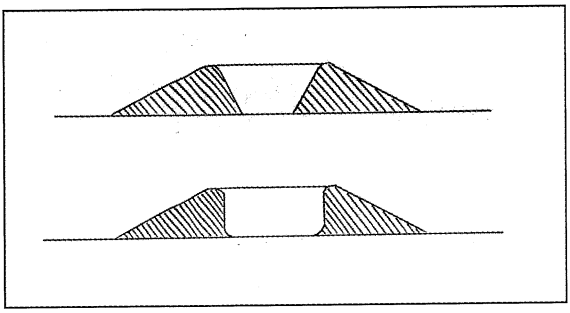

Fig. 2 - Side views of the conic and the cylindric pitfalls.

Sieved flour, previously infested by the two species for a period of four weeks, was used as attractive substance to select the most efficient trap. Infested flour resulted as the most attractive among different substances tested in previous studies (Locatelli *et al.*, 2005). Groups of 20 adults, 4-8 days old, of *Tribolium castaneum* and of *T.*

*confusum* (mixed population) were placed in groups of five at each of the four sides of the arena.

*Evaluation of pheromones and food attractants*

Groups of 20 adults, 4-8 days old, of *Tribolium castaneum* or of *T. confusum* were placed in groups of five at each of the four sides of the arena. In the middle of the arena the trap with one of the attractive substances was placed. The substances used to bait the trap were partially available on the market: standard dispenser (natural rubber), disk dispenser (expanded rubber) lured with 1 mg of 4,8-dimethyldecanal, and food attractant (cellulose disk imbued with 200$\mu$l of wheat germ oil), provided by Novapher S.a.S. (Milano); Pest Patrol (89.62% wheat germ oil, 9.96% inactive ingredients, 0.42% 4,8-dimethyldecanal) (Insect limited inc. USA), wheat germ oil, carob water extract.

Wheat germ oil was used because its triglycerides induce aggregation of adults of *T. castaneum* and *T. confusum* (Levinson & Levinson, 1978) and in other beetle species (Nara *et al.*, 1981; Nara & Burkholder, 1983). Extract of carob resulted attractive for different stored product beetles (Levinson & Levinson, 1978; O'Donnel *et al.*, 1983; Obeng-Ofori, 1993).

Four replications were carried out for each test. Data were submitted to ANOVA and Duncan's multiple range test.

## RESULTS

*Development of the trap*

Results of the test are shown in Table 1, where the number of adults caught by the four different types of trap was considered, and in Fig. 1, where the number of adults caught by each trap at 24, 48, 72 hours was compared.

*Table 1 - Mean number (±s.d.) of adults of* Tribolium castaneum *J. du Val and of* T. confusum *(Herbst) (mixed population) caught by the different traps activated with sieved wheat flour previously infested by the two species (20 adults present in the arena for each of the four replications).*

| Trap | Mean number of adults (±s.d.) | | | Min-max[a] |
|---|---|---|---|---|
| | 24hrs | 48hrs | 72hrs | |
| Squared/cylindric pitfall | 11.7±1.7a | 13.2±2.2a | 14.5±2.4a | 12-17 |
| Squared/conic pitfall | 6.2±0.9bc | 8.5±1.3b | 11.5±2.1ab | 9-14 |
| Rounded/ cylindric pitfall | 8.2±0.9b | 9.0±1.8b | 10.0±1.1b | 9-11 |
| Rounded/ conic pitfall | 5.7±1.7c | 7.2±1.9b | 10.7±2.2b | 8-13 |

Means followed by different letter in a column are significantly different (P<0.05, Duncan's multiple range test).
[a] Minimum - maximum at 72 hours.

The squared trap with the cylindric pitfall caught a significant higher number of adults than the other traps at 24, 48, and 72 hours (Table 1).

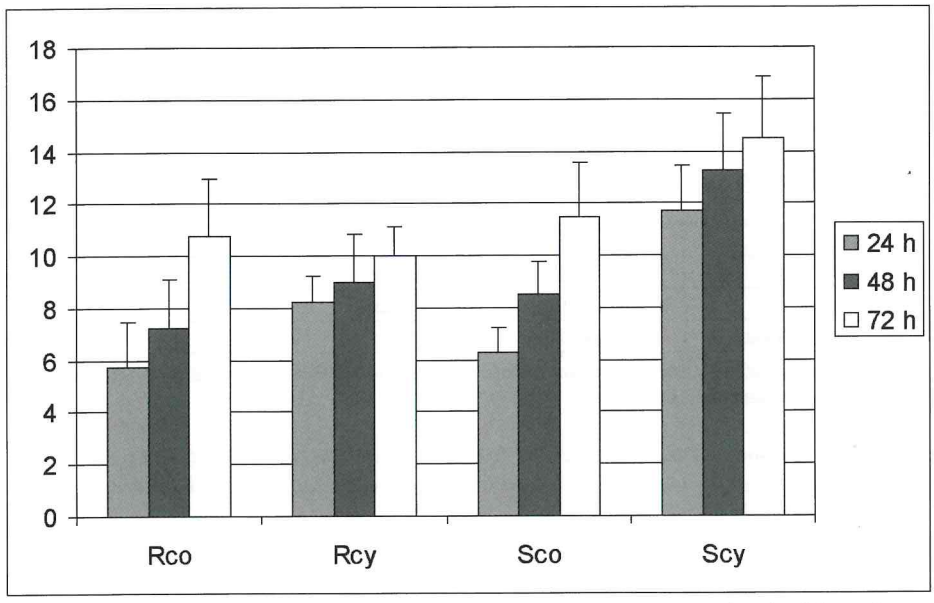


Fig. 3 - *Mean number (±s.d.) of adults of* Tribolium castaneum *J. du Val and of* T. confusum *(Herbst) (mixed population) caught by the different traps activated with sieved wheat flour previously infested by the two species (20 adults present in the arena for each of the four replications). Rco: rounded/conic pitfall; Rcy: rounded/cylindric pitfall; Sco: squared/conic pitfall; Scy: squared/cylindric pitfall.*

There were no significant differences in the number of adults caught at 24, 48, and 72 hours for the squared trap with cylindric pitfall and for the rounded trap with cylindric pitfall (Fig. 3).

*Evaluation of pheromones and food attractants*

The results of the tests on the effectiveness of the six attractants are reported in Tables 2 and 3.

The most attractant substances for the two species were Pest Patrol, standard dispenser and disk dispenser (containing 4,8-dimethyldecanal). Wheat germ oil showed the same attractiveness of the pheromone for *T. castaneum* (Tab. 2), while it showed the same poor activity of the food attractant for *T. confusum* (Tab. 3). Carob water extract showed a poor attractiveness for both the species.

The number of adults caught by the trap gradually increased with the time, but significant differences were not observed among the number observed at 24, 48, 72 hours except for the number of *T. castaneum* with the carob water extract (Duncan's multiple range test, $p \leq 0.05$).

*Table 2 - Mean number (±s.d.) of adults of* Tribolium castaneum *J. du Val caught by the squared trap with cylindric pitfall activated with the different baits (20 adults present in the arena for each of the four replications).*

| Bait | Mean number of adults (±s.d.) | | | Min-max[a] |
|---|---|---|---|---|
| | 24 h | 48 h | 72 h | |
| Standard dispenser | 13.7±5.05a | 15.0±4.24a | 16.5±3.69a | 12-20 |
| Disk dispenser | 12.7±2.06a | 14.5±2.08a | 17.5±1.29a | 16-19 |
| Pest Patrol | 17.2±2.98a | 18.0±3.36a | 18.2±2.87a | 14-20 |
| Food attractant | 3.5±2.51b | 4.7±1.7b | 5.7±1.7c | 4-8 |
| Wheat germ oil | 17.2±3.09a | 8.2±2.06a | 19.0±1.41a | 17-20 |
| Carob water extract | 3.5±0.81b | 5.7±0.95b | 10.7±2.36b | 9-14 |

Means followed by different letter in a column are significantly different (P<0.05, Duncan's multiple range test).
[a] Minimum - maximum at 72 hours.

*Table 3 - Mean number (±s.d.) of adults of* Tribolium confusum *(Herbst) caught by the squared trap with cylindric pitfall activated with the different baits (20 adults present in the arena for each of the four replications).*

| Bait | Mean number of adults (±s.d.) | | | Min-max[a] |
|---|---|---|---|---|
| | 24 | 48 | 72 | |
| Standard dispenser | 16.2±0.95a | 16.7±1.25a | 17.2±0.95a | 16-18 |
| Disk dispenser | 14.5±4.65a | 14.7±4.42ab | 16.2±3.3a | 13-20 |
| Pest Patrol | 16.0±2.94a | 17.0±3.16a | 17.7±2.62a | 15-20 |
| Food attractant | 4.0±2.44c | 4.2±2.06c | 5.5±1.29c | 4-7 |
| Wheat germ oil | 2.7±3.2c | 3.2±2.75c | 3.7±2.06c | 2-6 |
| Carob water extract | 10.0±1.63b | 10.7±2.5b | 11.7±2.5b | 9-15 |

Means followed by different letter in a column are significantly different (P<0.05, Duncan's multiple range test).
[a] Minimum- maximum at 72 hours.

## CONCLUSIONS

The results showed that the squared trap with cylindric pitfall caught a high number of adults of *Tribolium confusum* (Herbst) and *T. castaneum* J. du Val, when activated with attractants containing 4,8-dimethyldecanal.

The trap was designed to overcome the limitations of the traps on the market. The use of flocked PVC for the slants was crucial as flour beetles can cling and climb easily. A flat surface between the slants and the rim of the pitfall favoured insects movements towards the attractive substance. The pitfall made of smooth PVC with perpendicular walls favoured the falling and prevented insects from escaping the pitfall, while in the trap with conic pitfall the adults can easily climb the walls.

The two Novapher erogators and Pest Patrol, containing the flour beetles pheromone, were the most attractive baits.

The two species showed the same response to the attractants except for wheat germ

oil, which was attractive for *T. castaneum* but not for *T. confusum*. Levinson & Levinson (1978) observed a different attractiveness of wheat triglycerids to the two species.

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