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The KLP+ ("hat") trap, a non-sticky, attractant baited trap of novel design for catching the western corn rootworm *(Diabrotica v. virgifera)* and cabbage flea beetles (*Phyllotreta* spp.) (Coleoptera: Chrysomelidae)

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Summary: In the course of research aimed at the development of non-sticky, easy-to-use alternative trap designs for the capture of selected beetle pests, a newly designed "hat" trap, codenamed CSALOMON® KLP+, was compared with conventional trap designs. In the case of the western corn rootworm (WCR) *Diabrotica v. virgifera* (Coleoptera, Chrysomelidae) the new KLP+ traps baited with pheromonal or floral baits were equally sensitive as the former PAL or PALs sticky "cloak" designs, but the KLP+ traps catch capacity and selectivity was much higher. When baited with the floral WCR bait, the KLP+ trap proved to be more sensitive in capturing female WCR, than the former sticky PALs trap design.

In capturing cabbage flea beetles (*Phyllotreta* spp., Coleoptera, Chrysomelidae), the new KLP+ trap design baited with allyl isothiocyanate performed better than the previously used VARL+ funnel traps in all respects studied.

In conclusion, the new KLP+ trap design, baited with the respective attractants, appears to be advantageous to use for the trapping of both WCR and cabbage flea beetles, and can be recommended for use as a trapping tool in plant protection practice in the detection and monitoring of these pest Coleoptera.

Key words: KLP+ „hat" trap, trapping, western corn rootworm, *Diabrotica v. virgifera,* cabbage flea beetle, *Phyllotreta* spp., allyl isothiocyanate, monitoring, detection

Introduction

In the past couple of years in our laboratory special emphasis was put on the development of non-sticky pheromone trap designs, since the common disadvantage of all sticky traps is that due to gradual changes in the effective sticky surface in time, they are not suitable for the study of quantitative aspects (i.e. accurate measurement of changes in population density, establishment of threshold values, etc.) (*Wall*, 1989). From the practical point of view, other disadvantages of the use of sticky traps are that they can capture very many non-target insects coming to the sticky surface by chance, and in general, their assembling and maintenance is awkward (fingers of the user easily get covered by the sticky material). Non-sticky, high capture capacity trap desings may solve most of these problems.

To overcome difficulties of the use and maintenance of the sticky "cloak" traps (CSALOMON® PAL and PALs; all CSALOMON® traps are produced by Plant Prot. Inst., HAS, Budapest, Hungary) widely used in Europe for trapping of the western corn rootworm (WCR) (*Diabrotica v. virgifera* Le Conte) (Coleoptera: Chrysomelidae) (*Tóth* et al., 1996, 2003), recently a non-sticky modified funnel trap, the CSALOMON® VARs+ has been developed (*Tóth* et al., 2000a,b, *Imrei* et al., 2002). However, this trap design is quite complicated and is relatively difficult to set up in a maize field *(Fig 1).* Also, through direct observation of WCR coming to the VARs+ trap, we found that although WCR has a very strong urge to run upwards along any vertical surface, beetles find it hard to get into the upper catch container as there is no continuous physical substrate which would lead them directly into this catch container. In developing the new KLP+ (abbreviation comes from the Hungarian word for "hat" = "kalap") trap design we tried to correct these shortcomings of the VARs+ trap, by preserving the upper container part but replacing the lower funnel and catch container by a vertical pane along which insects could crawl up directly into the upper container and get caught. Since the most widespread and sensitive trap designs for capturing WCR are the sticky PAL and PALs, the

Photo 1 KLP+ trap baited with the floral bait catching WCR adults

Photo 2 KLP+ trap baited with the allyl isothiocyanate bait catching flea beetles

performance of the KLP+ trap was compared to theirs in the present study.

Since cabbage flea beetles (*Phyllotreta* spp.) (Coleoptera: Chrysomelidae) belong to the same family and show some similarities in behavior to WCR (they also prefer to crawl upwards along vertical surfaces), and also because for these species the powerful plant-derived attractant allyl isothiocyanate (*Görnitz*, 1953; *Matsumoto*, 1970; *Feeny* et al., 1970; *Vincent & Stewart*, 1984, *Pivnick* et al., 1992; *Tóth* et al., 2003a) was available, the new KLP+ trap design was tested also on this group of insects. Formerly the funnel trap CSALOMON® VARL+ baited with allyl isothiocyanate was found to be suitable for the capture of flea beetles (Tóth et al., 2004a), so in this group of insects the performance of the KLP+ trap was compared with that of the VARL+ trap.

Material and method

Experimental sites

Tests were run at several sites in Hungary and Italy. During the tests different treatments (= trap types) were set up in a block (one of each treatment). The distance of traps within a block was 8–10 m. The distance between blocks ranged between 20–50 m. At inspections, captured insects were recorded and removed from the traps. Inspections were performed at 2–3 day intervals.

Technical details of field tests:

- on WCR (all conducted in maize fields):

  Experiment 1 and 2: site Birago, Colnago, Milano district, Lombardy, Italy, August 19 – September 2, 2004; 4 replicate blocks ea.

  Experiment 3: Szekszárd, Tolna county, Hungary, July 1 – September 3, 2004; 4 replicate blocks.

  Experiment 4: Debrecen, Hajdú-Bihar county, Hungary, June 29 – October 8, 2004; 4 replicate blocks.

- on cabbage flea beetles:

  Experiment 5: Pusztazámor, Fejér county, Hungary, white mustard field, March 31 – September 22, 2005; 5 replicate blocks.

Trap types

Trap types tested were members of the CSALOMON® trap family (used for the capture of many moth and beetle spp. by the Budapest laboratory).

• *PAL traps:* sticky "cloak" traps (*Tóth* et al., 1998, 2003b) were prepared from transparent plastic sheets (36 × 23 cm). One side was covered with sticky material. When setting up, the sticky sheet was placed around a maize stem in a "cloaklike" manner, with the sticky side facing outward, and the back corners were fastened together with clips. The trap was kept in place by a piece of wire, attached to the maize stem. The bait dispenser was fastened to the front top edge of the trap, with the bait hanging in front of the sticky surface. The *PALs* traps were of same dimensions and design, but instead of transparent the sticky sheet was painted yellow (for reflectance spectrum of yellow paint used please refer to *Tóth* et al., 2004b).

• *VARL+ traps:* *Figure 1* shows basic design of the trap. Originally this funnel trap type was developed for the capture of larger moths (i.e. noctuids, geometrids, etc.) (*Tóth* et al., 2000a, Subchev et al., 2004). The trap consists of a plastic funnel, which is covered by a flat plastic roof, and below there is a ca 0.7 litre plastic catch container. The bait was attached to the roof, so that the bait dispenser was positioned into the middle part just below the roof.

• *KLP+ traps*: *Figure 1* shows basic design of the trap. The catch container is made of a 0.75 litre transparent PVC salad bowl with lid (No. 6168, PANNUNION, Szombathely, Hungary). The catch container is placed upside down, and a 5 cm diameter hole is punched into the center of the lid. A 20 cm x 20 cm panel of 0.3 mm thick polystyrol painted yellow (same hue as in PALs) is suspended vertically from the hole in the lid. Inside the catch container an upward leading funnel made of transparent plastic sheet (larger opening fits opening of container, smaller opening diameter 1.5 cm, height 7 cm) hampers escaping of beetles getting inside the trap. The bait is attached to the vertical plastic panel, ca 1–2 cm below the central large opening in the lid of the container. The trap is suspended by ribbons from a pole or parts of the vegetation.

In case of the VARL+ and KLP+ trap designs for killing insects captured we added a small piece (1×1 cm) of a household anti-moth insecticide strip (Chemotox® SaraLee, Temana Intl. Ltd, Slouth, UK; active ingredient 15% dichlorvos) into the catch container.

Baits

WCR pheromone commercial baits (CSALOMON®) were used in experiments comparing PAL traps. These contained racemic 8-methyl-2-decyl propanoate as active ingredient (*Guss* et al., 1982, *Tóth* et al., 2003b). In tests with PALs traps, commercial WCR floral baits (CSALOMON®) were used, which contained 4-methoxy-cinnamaldehyde and indole (*Metcalf* et al., 1995, *Tóth* et al., 2003b).

In tests with cabbage flea beetles polyethylene dispensers (0.7 ml polythene vial with lid; No. 730, Kartell Co., Italy) loaded with allyl isothiocyanate were used.

Statistics

Capture data were transformed to $(x+0.5)^{1/2}$ and were analysed by Student *t* test (see also Table and Figure legends).

All statistical procedures were conducted using the software packages StatView® v4.01 and SuperANOVA® v1.11 (Abacus Concepts, Inc., Berkeley, CA, USA).

Results and discussion

WCR captures

In traps baited with pheromone, mean catches in KLP+ or PAL traps were not significantly different (*Table 1*). When the seasonal distribution of catches was studied (*Figure 2*), catches throughout all the season showed similar trends and did not show any seasonal differences between the two trap designs.

When floral-baited traps (KLP+ vs. PALs) were compared, again there was no apparent difference neither in mean catches (*Table 1*) nor in the seasonal distribution of catches (*Figure 3*), as far as unsexed catch data were concerned.

Table 1 Mean catches of WCR in different trap designs baited with pheromone or with floral bait. P values derive from Student t test

Baited with pheromone bait		
Trap design	Mean / trap / inspection (+SE)	
	Exp. 1.	Exp. 3.
PAL (w. pheromone bait)	9.50+2.41	37.03+9.23
KLP+ (w. pheromone bait)	10.33+4.20	43.67+8.18
P value	0.7429	0.3260
Baited with floral bait		
Trap design	Mean / trap / inspection (+SE)	
	Exp. 2.	Exp. 4.
PALs (w. floral bait)	8.08+2.68	283.03+25.35
KLP+ (w. floral bait)	27.25+11.28	298.75+29.60
P value	0.1038	0.822

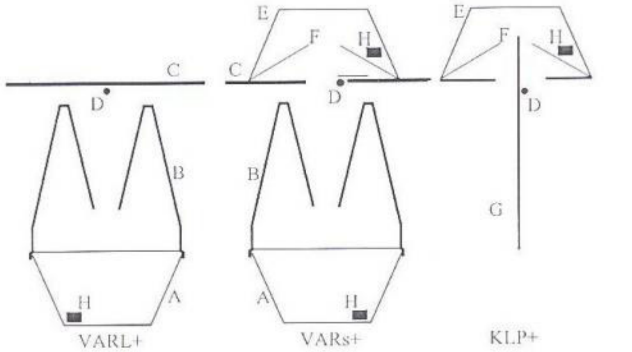

Fig 1 Diagrams of cross view of non-sticky trap designs. A = lower catch container (transparent plastic); B = plastic funnel; C = plastic lid; D = bait dispenser; E = upper catch container (transparent plastic); F = cone (transparent plastic); G = crawl-up plastic panel (yellow); H = small piece of anti-moth strip

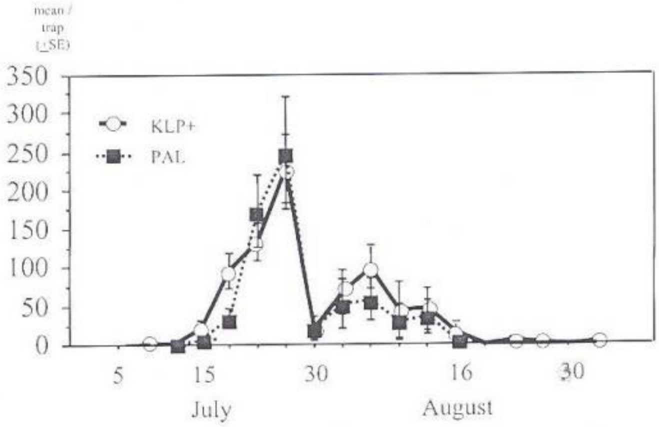

Fig 2. Seasonal distribution of mean WCR catches in KLP+ and PAL traps baited with pheromone. (Experiment 3; total caught in test: 6077 beetles.)

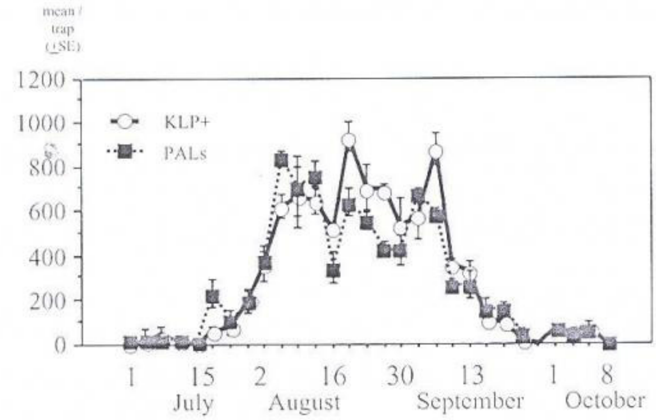

Fig 3. Seasonal distribution of mean WCR catches in KLP+ and PALs traps baited with the WCR floral bait. (Experiment 4; total caught in test: 66890 beetles.)

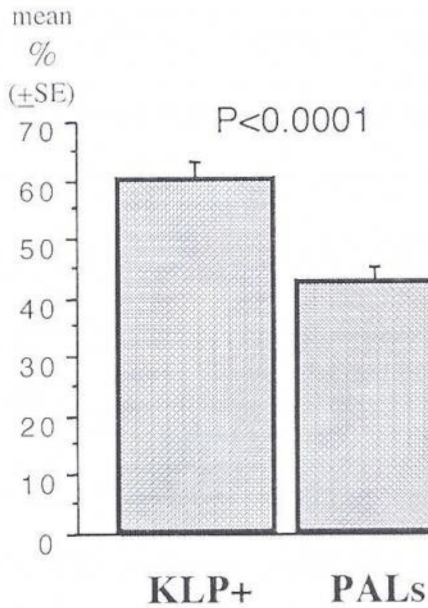

Fig 4. Mean female percentages of WCR in catches of KLP+ and PALs traps baited with the WCR floral bait. (Experiment 4; total caught in test: 66890 beetles.)

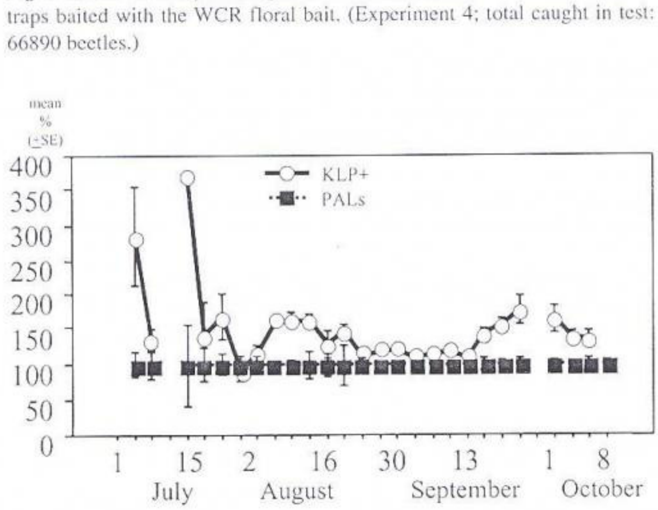

Fig 5. Mean female ratio (%) of WCR in KLP+ and PALs traps baited with the WCR floral bait, shown normalized against female ratio in PALs at the single inspection dates in the course of the experiment. Data from Exp. 4.

However, when the female ratio of the catches was analysed, the KLP+ traps caught females in a significantly higher ratio than the PALs traps (*Figure 4*). When ratio of females were compared at each inspection date throughout the season (normalized against female ratio in catches by PALs traps at the given date), female ratio was always higher in KLP+ traps than in PALs traps (*Figure 5*), corroborating the evaluation of mean ratios / trap / inspection (*Figure 4*).

Generally KLP+ traps were catching far less non-target insects, than the sticky PAL and PALs designs, since the open sticky surface of these latter captured randomly many flying insects apart from WCR.

In conclusion, the non-sticky KLP+ traps were not inferior to the sticky trap designs, neither in sensitivity nor in catch capacity, no matter whether they were baited with pheromone or floral baits of WCR. On the other hand, the KLP+ traps with floral bait seemed to be more suitable for the capture of females than the sticky PALs design. This suggests that the KLP+ trap design is especially suitable for the capture of females. Female selectivity could be enhanced by the development of more female selective bait compositions than the present-sday commercial WCR floral bait. First results on an improved female WCR bait have recently been reported (*Hammack*, 2001).

Cabbage flea beetle captures

In the test sizeable numbers were caught from the following *Phyllotreta* spp.: *Ph. cruciferae* Goeze, *Ph. vittula* Redtenbacher, *Ph. nigripes* Fabr., and the closely related *Psylliodes chrysocephalus* L. The mean number of beetles caught were significantly higher in the KLP+ traps than in the VARL+ traps in case of all four species captured (*Figure 6*).

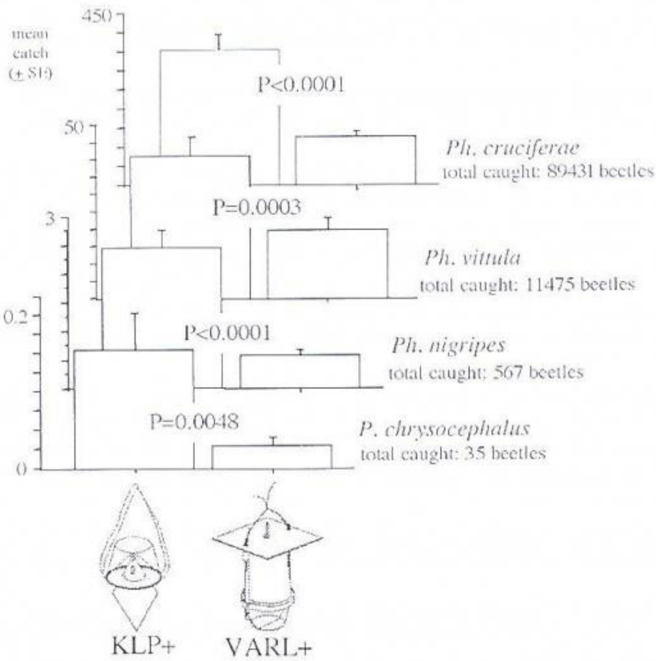

Fig 6. Mean catches of *Phyllotreta* spp. and *Psylliodes chrysocephalus* in KLP+ and VARL+ traps baited with allyl isothiocyanate bait. (Experiment 5)

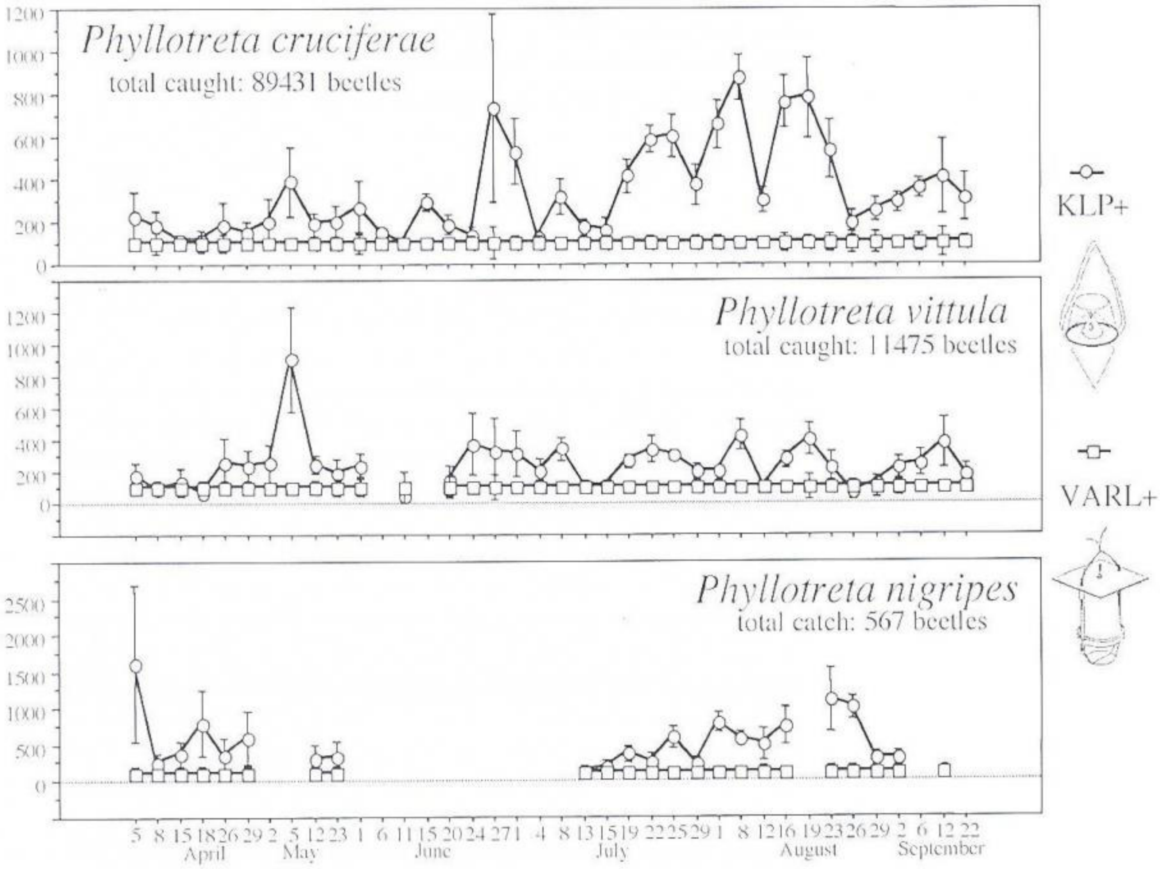

Fig 7. Mean catches of *Phyllotreta* spp. in KLP+ and VARL+ traps baited with the allyl isothiocyanate bait., shown normalized against catches in VARL+ at the single inspection dates in the course of the experiment. Data from Exp. 5.

When catches at each inspection date were compared throughout the period of the test (for easier comparison normalized against the mean catch in VARL+ traps), in *Ph. cruciferae* captures in KLP+ traps were higher than those in VARL+ traps on the vast majority of inspection dates (*Figure 7*). Catches of *Ph. vittula* and *Ph. nigripes* showed the same trend, with KLP+ traps generally performing better (*Figure 7*); inspections with no data caught nil in the VARL+ traps.

In conclusion, the new KLP+ trap design proved to be advantageous for use for the trapping of both WCR and cabbage flea beetles tested in the present study. It may prove to be suitable also for the capture of other beetles, provided an attractant is available for the given species. Tests on selected weevils, nitidulids and other Coleoptera are underway and will be reported on in the near future.

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