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Phenylacetaldehyde Trapping of *Ostrinia nubilalis* (Hb.), *Autographa gamma* (L.) and Hoverflies: Trap Design Efficacy (*)

Introduction

The ability of phenylacetaldehyde (PAA) to attract Lepidoptera adults especially *Ostrinia nubilalis* (Hb.) (Lepidoptera Pyralidae) European Corn Borer (ECB) has been demonstrated by Cantelo and Jacobson (1979a, b). More recently, PAA has been found to attract *O. nubilalis* females and at lesser extent males in maize and to enable the capture of more males together with females of this moth when cone traps are also baited with a sex pheromone blend (Maini and Burgio, 1990). While the latter finding results in enhanced ECB detection (Maini and Burgio, 1993), its source trial did not provide conclusive evidence of synergic or antagonist effect of PAA on males.

A notable alternative use of PAA is reported by Landolt *et al.* (1991), who employed a field-cage system that attracts *Trichoplusia ni* (Hb.) with PAA, and then kills the pest with a solution containing sucrose and 1% methomyl. Given a mortality rate of 61% for the females and 44% for the males, these authors underscore the effectiveness of their approach in attracting and killing *T. ni* and/or other moth pests attracted by PAA.

In addition to PAA's proven value as a field attractant, trap design also is known to be an important factor in trapping *O. nubilalis* males. A number of studies have focused on the comparative effectiveness of blacklight (BLT) and pheromone traps (PT) in the ECB monitoring. The BLT usually prove to be more effective than sticky PT traps in detecting *O. nubilalis* males (Kennedy and Anderson, 1980). However, Fletcher-Howell *et al.* (1983) found that Pherocon sticky traps were more useful in surveying first flight, although the second-flight peak was two weeks later with this PT than with the BLT. Thompson *et al.* (1987) report that while at low ECB population densities catches in aerial water-pan PT and BLT were not significantly different, they were greater with BLT at higher population densities; they also note that the aerial water pan PT was more effective and practical

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to use than the Pherocon PT. Oloumi-Sadeghi *et al.* (1975) demonstrated a lack of seasonal synchrony between BLT and PT captures, and postulated that the captures with the PT lag behind those with the BLT because the females are competing for males; Legg and Chiang (1984) point out that the BLT and PT measure different responses from the male moth. Field tests have shown too that cone traps (*Heliothis* Scentry Trap) are more effective than the sticky ones (Durant *et al.*, 1986; Webster *et al.*, 1986; Maini and Burgio, 1990; Zandigiacomo *et al.*, 1993). The effect of trap placement, whether inside or outside the target field, has been reported by Derrick *et al.* (1992).

The present study is designed to rate the efficacy of three types of cone traps and the sticky trap in capturing *O. nubilalis* adults, other insects such as *Autographa gamma* (L.) (Silver Y), and different species of Syrphidae (hoverfly), and to evince more clearly the additive effect of PAA on the captures of both ECB males and females.

Materials and Methods

The sticky and the three types of cone traps were tested in field trials from 1990 to 1992 at various sites in the neighbouring northern Italian provinces of Bologna and Modena, although not all the traps were involved in each trial year.

Trap design. Fig. I. The sticky Traptest® (Isagro, Novara, Italy) units were of the standard type and tested in 1990 and 1991. The cone trap indicated as "XLa", tested in all three trial years (1990-92), is made of a metal frame covered with a fine plastic mesh (25 cm opening at the base, 70-75 cm height and 3.5 cm opening at the top) and the top opening features an inter-changeable capture chamber for insect made of the same material as the trap itself, and attached to the latter by a thin metal wire. The cone trap "L", tested in 1990 and 1991, is basically the same as the "XLa" but smaller (20 cm base opening, 35 cm height and 3.5 cm top opening), without the metal frame and with an inter-changeable top capture chamber sheathed in a fine-mesh cylinder supported by a plastic holder and attached to the trap by a small wire frame. The "XLb" cone, tested in 1992, is similar in construction to the "XLa" (28 cm base opening, 60 cm height and 4 cm top opening) except for its removable top capture chamber and the fact that it can be folded to facilitate transport.

Pheromone lures. All the trials employed rubber septa with 0.1 mg sex pheromone blend (97:3)*E*:*Z*-11-tetradecenyl acetate (*E*:*Z*-11-14Ac) that were replaced every two weeks. The lures were attached to the base of the three types of cone traps and suspended inside the Traptest® ones so as to prevent the inhibitory substance in the dispenser from being absorbed by the adhesive and to enable it to continue repelling the moths even after a new lure was placed in the trap (McLeod and Starrat, 1978).

PAA food lure. PAA was released in the amount of 100 mg (Maini and Burgio, 1990) by dispensers and attached to the traps as were the pheromone lures above; they were replaced once a month.

Trap position. All the traps were hung by a cylindrical metal support tube at a height of about 1 m, at the edge of the corn fields and spaced over 20 m apart.

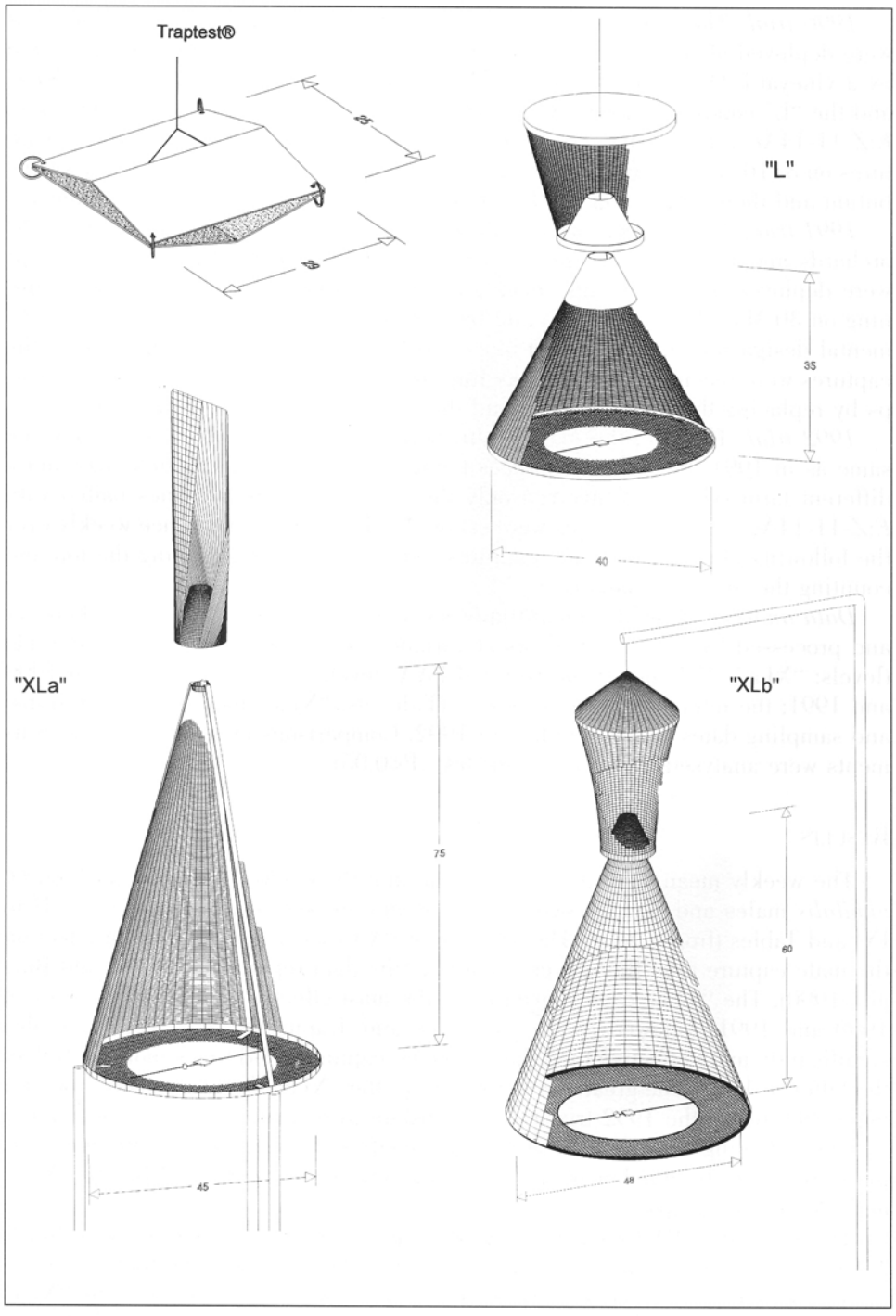

Fig. I. - Traps used in field trials. Unit of misure: cm.

1990 trial. The site was a farm at Mercatale in Bologna Province. The traps were deployed along the edges of a cv. 'Nelson' maize field (4-5000 m^2) bordered by a vineyard. Of the three tested traps, *i.e.* the sticky Traptest® and the "XLa" and the "L" cones, 3×2 rep., were baited with *E*:*Z*-11-14Ac and 3×2 rep., with *E*:*Z*-11-14Ac + PAA. The traps were installed on 27 July and monitored for captures on 3, 10, 17 and 24 August; the experimental design consisted of trap distribution and their rotation on each sampling date to prevent placement influence.

1991 trial. This site was a cv. Dallas sweet-maize field (3-3.5 ha) bordered by orchards and horticultural crops at Camposanto in Modena Province. The traps were deployed on 20 May and monitored once weekly for thirteen weeks beginning on 30 May. The same traps and baits were tested as in 1990 and the experimental design was in randomised blocks with four replications. In both years the captures were recorded for the sticky trap by simple counting and for the cone traps by replacing the removable top and then counting the insects in laboratory.

1992 trial. The site, the maize cultivar and the experimental set up were the same as in 1991, the only differences being in a larger 4-4.5 ha field size and a different farm. This trial involved only the "XLa" and "XLb" cones baited with *E*:*Z*-11-14Ac + PAA. The traps were set on 27 May and sampled once weekly over the following eleven weeks; the captures were recorded by replacing the top and counting the insects in laboratory.

Data analyses. Insects caught/trap/week were transformed to log (x + 1) or $\sqrt{x}$ and processed by factorial analysis of variance. The factors were trap design (T) (levels: "XLa", "L" and Traptest®) and PAA (levels: no PAA, yes PAA) in 1990 and 1991; the interaction of trap design (T)(levels: "XLa" and "XLb" cone traps) and sampling dates (S) was studied in 1992. Comparisons of more than two treatments were analysed by Tukey's HSD test ($P<0.05$).

Results

The weekly mean capture rates per trap and their ANOVA values for both *O. nubilalis* males and females over the test years are shown in Figures (from II to IX) and Tables (from 1 to 8). The addition of PAA evinced no significant effect on the male capture rate, thereby corroborating the data reported by Maini and Burgio (1990). The "XLa" cone proved to be the most effective in detecting males in 1990 and 1991, followed by the "L" cone and Traptest®; the "XLa" was also significantly more effective than the "L" cone, capturing 7-8 times more ECB than the latter in 1991. The greater effectiveness of the "XLa" than the "XLb" cone for male captures in the 1992 trial proved constant over time, *i.e.* it was not influenced by sampling date (T*S: $P>0.05$). By contrast, a significant difference was found between the number of female captures/trap/week exhibited by the "XLa" and "XLb" cone traps.

The addition of PAA confirmed its attractant power for the ECB females. In the 1991 trial the "XLa" was, once again, significantly more effective than the Traptest®, whereas the "L" cone evinced an efficacy intermediate between the "XLa" and the Traptest®. While similar findings were recorded in the 1990 trial, the traps were deployed in the field only four weeks and the resulting greater variability

Tab. 1 - Mean ECB males/trap/week (± s.e.) (1990).

Bait	XLa cone	L cone	Traptest	Mean ± s.e.
E:Z -11-14Ac	13.25 ± 5.58	2.37 ± 0.94	0.25 ± 0.14	5.29 ± 2.42
E:Z -11-14Ac + PAA	5.75 ± 1.49	1.62 ± 0.12	0.50 ± 0.28	2.62 ± 0.82
Mean ± s.e.	9.50 ± 3.02 a	2.00 ± 0.46 b	0.37 ± 0.15 c	

Tab. 2 - Mean ECB males/trap/week (± s.e.) (1991).

Bait	XLa cone	L cone	Traptest	Mean ± s.e.
E:Z -11-14Ac	37.42 ± 7.54	3.11 ± 0.47	0.86 ± 0.22	13.80 ± 5.53
E:Z -11-14Ac + PAA	22.76 ± 3.49	4.45 ± 2.36	0.94 ± 0.18	9.39 ± 3.15
Mean ± s.e.	30.09 ± 4.74 a	3.78 ± 1.14 b	0.90 ± 0.13 c	

Tab. 3 - P value of ANOVA related to ECB males captures.

Source of variation	1990		1991	
	F	P	F	P
PAA	0.6	> 0.05	0.6	> 0.05
Traps (T)	26.88	< 0.001	162.6	< 0.0001
Blocks	3.9	< 0.05	5.1	< 0.05
PAA*T	0.8	> 0.05	1.6	> 0.05

Tab. 4 - Mean ECB females/trap/week (± s.e.) (1990).

Bait	XLa cone	L cone	Traptest	Mean ± s.e.
E:Z -11-14Ac	0.00 a	0.00 a	0.00 a	0.00
E:Z -11-14Ac + PAA	2.12 ± 0.74 a	0.62 ± 0.37 ab	0.25 ± 0.25 b	1.00 ± 0.35
Mean ± s.e.	1.06 ± 0.52	0.31 ± 0.20	0.12 ± 0.12	

Tab. 5 - Mean ECB females/trap/week (± s.e.) (1991).

Bait	XLa cone	L cone	Traptest	Mean ± s.e.
E:Z -11-14Ac	0.05 ± 0.03 a	0.00 a	0.00 a	0.01 ± 0.01
E:Z -11-14Ac + PAA	2.00 ± 0.55 a	0.95 ± 0.22 ab	0.35 ± 0.06 b	1.11 ± 0.27
Mean ± s.e.	1.02 ± 0.44	0.48 ± 0.20	0.19 ± 0.07	

Tab. 6 - P value of ANOVA related to ECB females.

Source of variation	1990		1991	
	F	P	F	P
PAA	15.2	< 0.01	158.01	< 0.0001
Traps (T)	2.8	≈ 0.05	13.5	< 0.001
Blocks	2.4	> 0.05	2.3	> 0.05
PAA*T	2.8	≈ 0.05	5.4	< 0.05

Tab. 7 - Mean ECB/trap/week (± s.e.) (1992).

males		females	
XLa cone	XLb cone	XLa cone	XLb cone
12.75 ± 4.02	6.22 ± 1.82	2.59 ± 0.91	2.68 ± 0.91

Tab. 8 - P value ANOVA related to ECB males and females (1992).

Source of variation	Males		Females	
	F	P	F	P
Sampling dates (S)	18.4	< 0.0001	158.01	< 0.0001
Traps (T)	10.6	< 0.01	2.5	> 0.05
Blocks	3.01	< 0.05	1.6	> 0.05
S*T	1.04	> 0.05	1.07	> 0.05

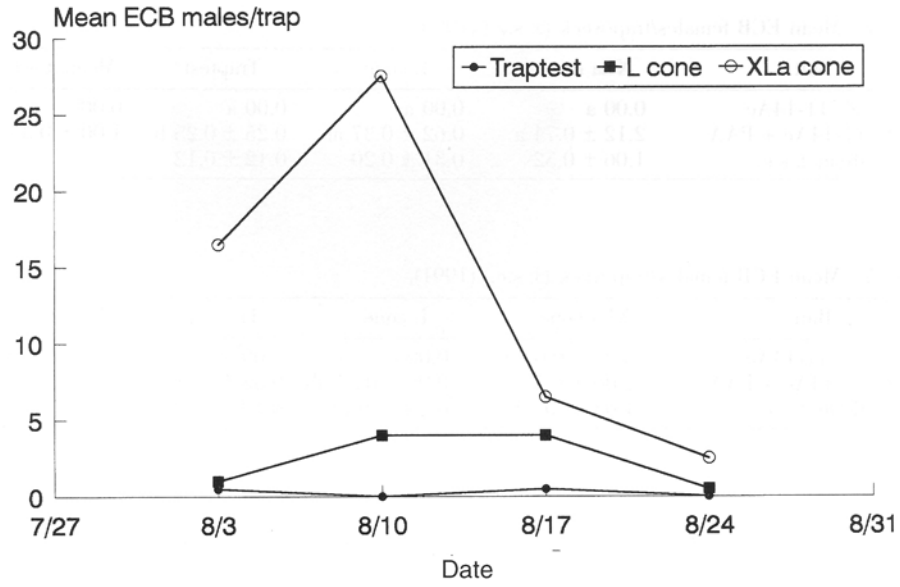

Fig. II. - Mean number of *O. nubilalis* males captured with (*E*:*Z*-11-14Ac) in 1990.

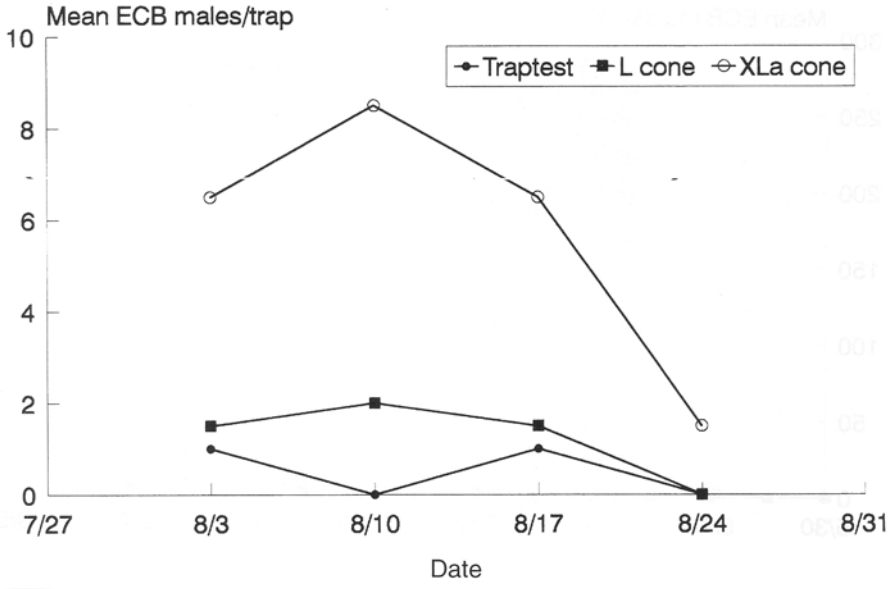

Fig. III. - Mean number of *O. nubilalis* males captured with (*E*:*Z*-11-14Ac) + PAA in 1990.

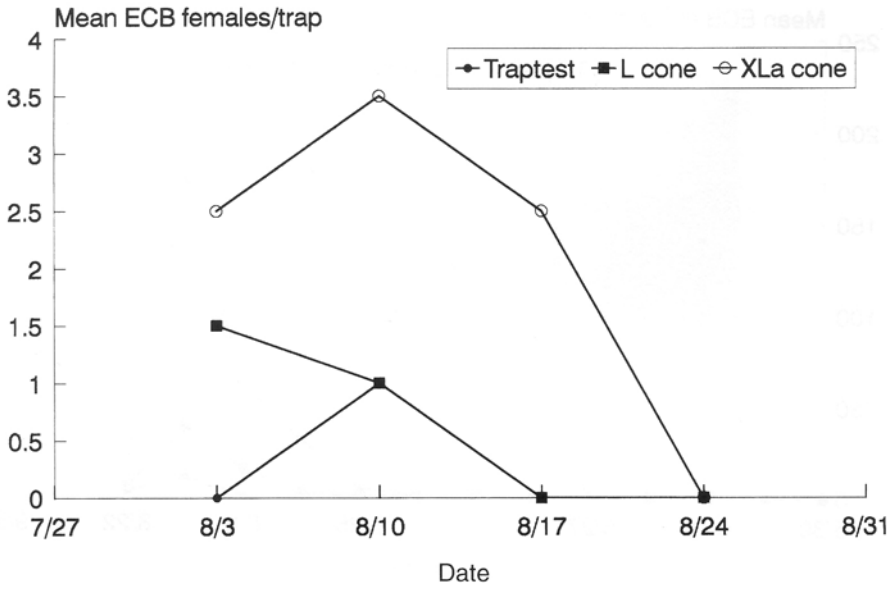

Fig. IV. - Mean number of *O. nubilalis* females captured with PAA in 1990.

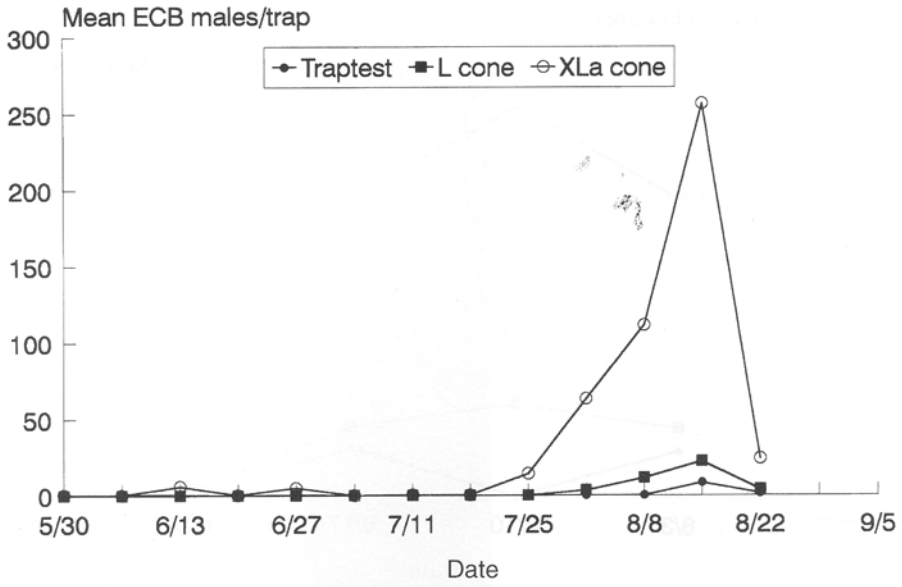

Fig. V. - Mean number of *O. nubilalis* males captured with (*E*:*Z*-11-14Ac) in 1991.

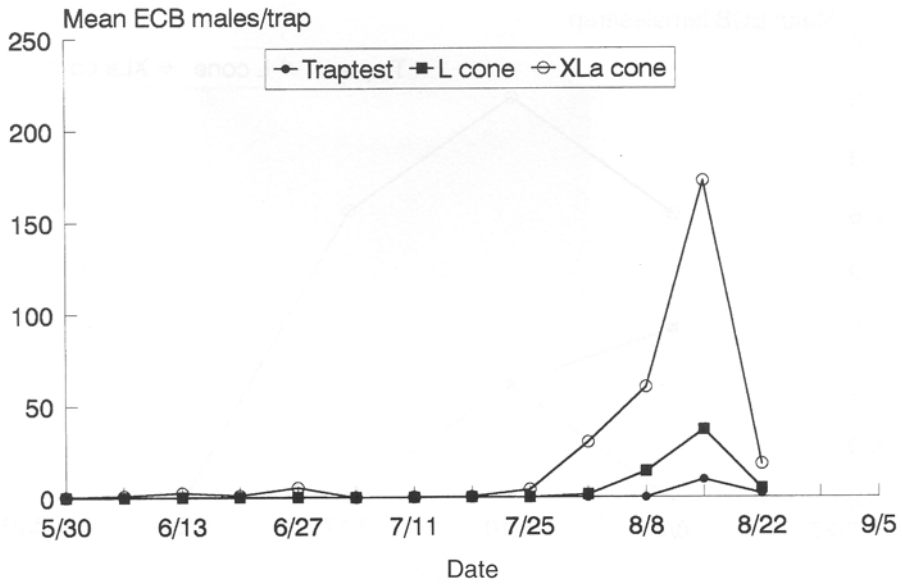

Fig. VI. - Mean number of *O. nubilalis* males captured with (*E*:*Z*-11-14Ac) + PAA in 1991.

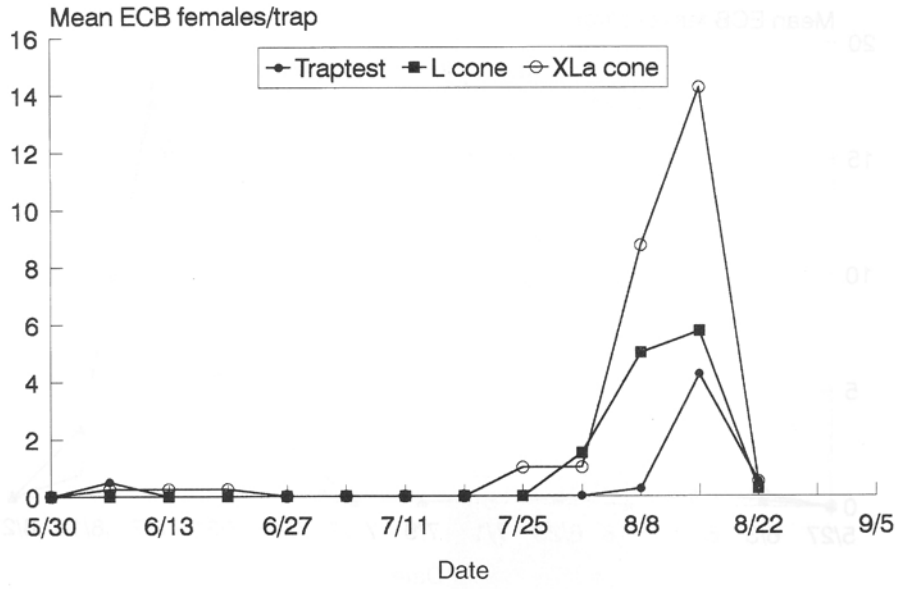

Fig. VII. - Mean number of *O. nubilalis* females captured with PAA in 1991.

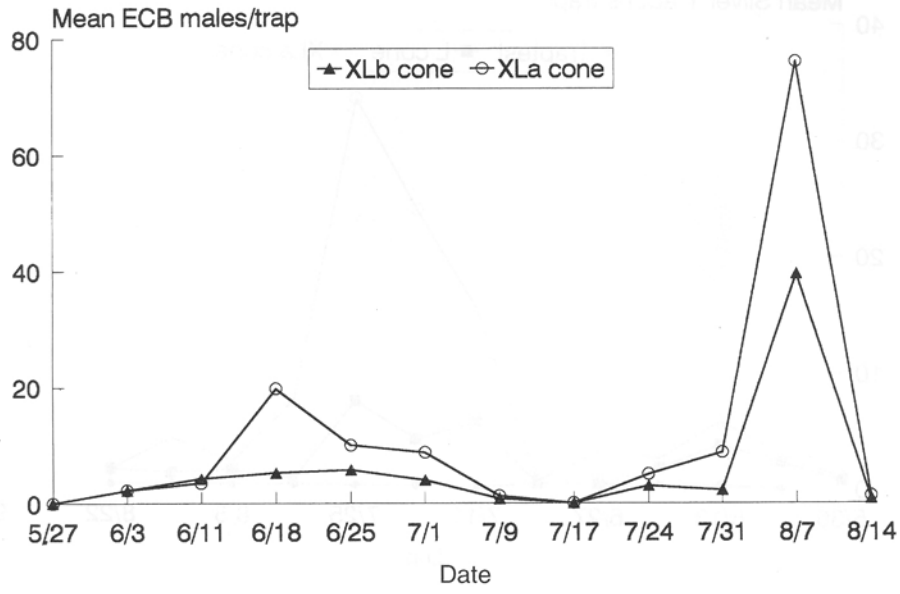

Fig. VIII. - Mean number of *O. nubilalis* males captured with (*E*:*Z*-11-14Ac) + PAA in 1992.

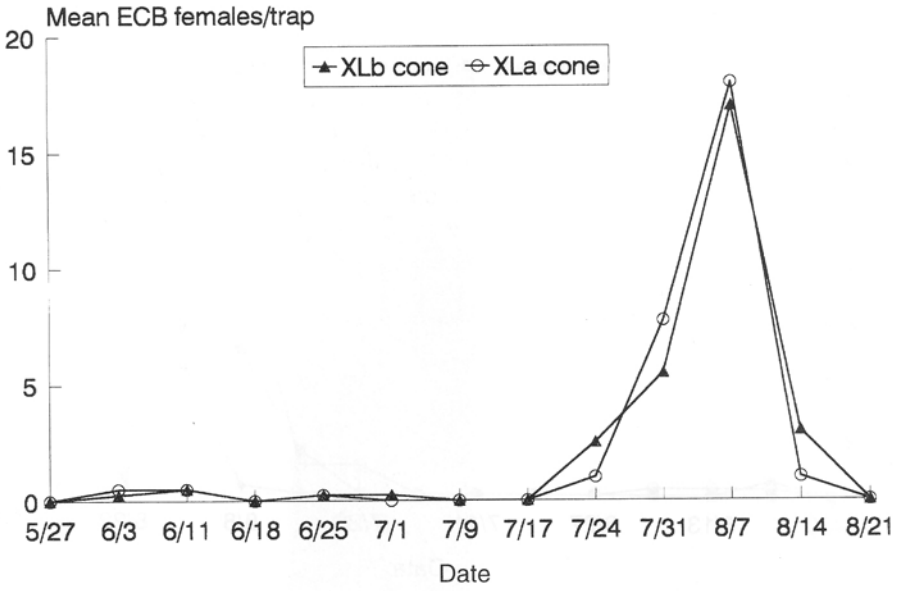

Fig. IX. - Mean number of *O. nubilalis* females captured with PAA in 1992.

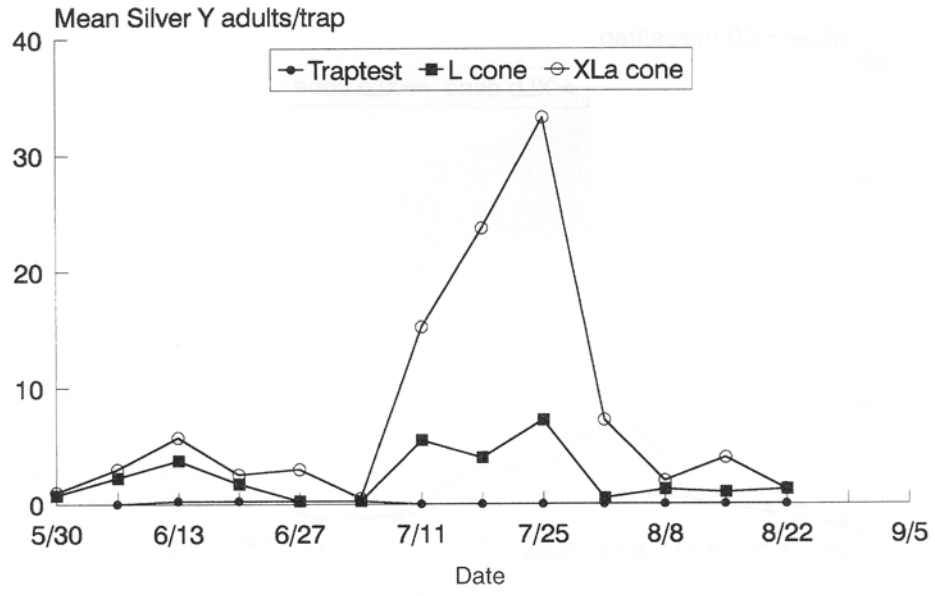

Fig. X - Mean number of *A. gamma* adults captured with PAA in 1991.

gave rise to slight differences in processed data values (Tabs. 4, 5). Note too that the ECB population in 1990 was lower than in 1991.

The male and female flight data of *O.nubilalis* for the tested traps are compared in Fig. II. The "XLa" cone evinced a greater capture efficiency and earlier capture date (1-2 weeks ahead) than the other tested traps, thereby exhibiting an enormous practical advantage in timing the usual treatments against ECB second generation on maize in northern Italy. The "XLa" cone proved almost the only traps to have detected ECB in the first generation, which was very low numerically in this field in 1991. This may have been due to a delay in the sowing of the sweet corn and its very early development stage at the time of first flight.

The addition of PAA resulted in a significant rise in the captures of *A. gamma* (Tabs. 9 and 12); its flight pattern is shown in Fig. X. Here, again, the "XLa" cone proved more effective than either the "L" or the Traptest®, the latter registering almost no captures. A highly significant interaction was found between the addition of PAA and trap type. While *A. gamma* is a markedly polyphagous insect, it does not induce economic damage to sweet corn, although under particular conditions it can give rise to irregular infestations of certain grass and horticultural crops.

Noteworthy is the significant attraction to PAA of hoverflies, especially with the cone trap (Tabs. 10 and 12). PAA, which is found in the flowers of higher plants (Cantelo and Jacobson, 1979a; 1979b; Haynes *et al.*, 1991), seems to be picked up by the adults of this Diptera group, which are known to be important pollinators for many plants. The species captured and their numbers are listed in Table 11.

Tab. 9 - Mean *A. gamma* adults/trap/week (± s.e.) (1991).

Bait	XLa cone	L cone	Traptest	Mean ± s.e.
E:Z -11-14Ac	0.05 ± 0.03 a	0.00 a	0.00 a	0.01 ± 0.01
E:Z -11-14:Ac + PAA	8.07 ± 1.12 a	2.21 ± 0.44 b	0.07 ± 0.07 c	3.45 ± 1.08
Mean ± s.e.	4.06 ± 1.60	1.10 ± 0.46	0.03 ± 0.03	

Tab. 10 - Mean Hoverflies/trap/week (± s.e.) (1991).

Bait	XLa cone	L cone	Traptest	Mean ± s.e.
E:Z -11-14Ac	4.65 ± 1.36	0.44 ± 0.19	0.19 ± 0.04	1.76 ± 0.74
E:Z -11-14Ac + PAA	6.80 ± 1.07	2.05 ± 0.47	0.67 ± 0.19	3.17 ± 0.86
Mean ± s.e.	5.73 ± 0.90 a	1.25 ± 0.38 b	0.43 ± 0.13 c	

Tab. 11 - Hoverfly caught by trap baited with PAA; % = relative abundance.

	%
Eristalis tenax (L.)	0.27
Eristalis arbustorum (L.)	0.97
Eristalinus aeneus (S.)	0.55
Scaeva pyrastri (L.)	0.27
Eupeodes corollae (F.)	35.62
Sphaerophoria scripta (L.)	47.7
Episyrphus balteatus (Degeer)	0.92
Melanostoma Schiner sp.	10.44
Syrphus F. sp.	0.13

Tab. 12 - P value of ANOVA related to *A. gamma* and Syrphidae captures.

Source of variation	*A.gamma*		Syrphidae	
	F	P	F	P
PAA	391.7	< 0.0001	33.2	< 0.0001
Traps (T)	124.2	< 0.0001	114.8	< 0.0001
Blocks	2.5	> 0.05	8.1	< 0.01
PAA*T	112.6	< 0.0001	2.4	> 0.05

Discussion and Conclusions

The data recorded in these trials once again reiterate the importance of trap design and size in capturing *O. nubilalis*, *A. gamma* and Syrphidae. The cone shape is the most effective, registering a marked superiority over the sticky Trapte-st® model in ECB captures; the latter trap type should no longer be used in ECB monitoring programs. The cone traps, and especially the "XLa", caught more *O. nubilalis* adults and proved more accurate in detecting the onset of ECB second flight, hence its marked practical value. The cone traps are also easy to handle for field agents and growers alike, and have the added advantage for research of capturing ECB and other insects alive. The sticky trap, apart from being less capture-sensitive, exhibits problems linked, for example, to the loss of the effectiveness of the sticky bottoms over time because of dust accumulation.

The "XLa" proved to be the most effective of the cone traps tested in males capture. Given that the bottom and top entry openings in both the "XLa" and "L" cones are practically the same, the lower number of captures by the latter model may be attributable to the smaller size of both its support-frame and cone-frame, a factor that might enable more captured adults to escape. The greater number of *O. nubilalis* males captured by the "XLa" as opposed to the "XLb" cone may depend on the greater height of "XLa" (75 against 60 cm). The base angle of the cone may be important to the retention of adults caught, particularly of the males.

The lack of any synergism in male captures for the traps baited with *E*:*Z*-11-14Ac + PAA is confirmed by our data. The male capture rate might not increase further because of a possible deterrent effect of the captured adults (male and female) or because of the pheromone's masking PAA. The former assumption deserves to be followed up given the discovery of a sex pheromone released by *O. nubilalis* males (Royer *et al.*, 1992). No deterrent effect of male pheromone on other males have been found yet.

The wide-ranging attraction of PAA with respect to other Lepidoptera species might complicate slightly the monitoring of *O. nubilalis* on sweet corn. For example, the capture of two species of *Leucania* with pheromone traps has increased monitoring time Weber and Ferro (1992). The number of individuals of the other species attracted by PAA in our tests was not a problem, and the use of PAA on sweet pepper made it possible to count the species that can sometimes inflict damage to this crop (Burgio and Maini, 1991). The capture of ECB females with PAA may be of practical value in IPM, and tests are now under way to determine the threshold captures for maize and, given the marked economic damage to it, for sweet pepper (Maini and Burgio, 1989; 1993).

The "XLa" traps were more efficient than "L" trap in capturing *A. gamma* confirming that the size has great importance in trapping moths. Hoverflies too were caught in higher number by "XLa" traps. Similarly designed cone traps have been employed to collect Diptera so far, with and without different kind of baits. During our trials, hoverflies were caught in unbaited traps (actually baited with ECB sex pheromone blend alone) but significantly less frequently than in the same type of cone traps with PAA lure added. Given that hoverflies are important pollinators and many species are efficient aphid predators too, PAA baited traps could be adopted as a monitoring or sampling tool for these Diptera in various agroecosystems.

KEY WORDS: Phenylacetaldehyde, Trap design, Sex pheromone, *Ostrinia nubilalis*, *Autographa gamma*, Hoverflies.

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SUMMARY

Sticky Traptest® and three types of cone traps were tested in corn fields from 1990 to 1992 to evaluate trap design efficacy in capturing *Ostrinia nubilalis* (Hb.) (ECB), *Autographa gamma* (L.) (Silver Y), and different species of Syrphidae (hoverfly).The traps were baited with the ECB sex pheromone (97:3, *E*:*Z*-11-14Ac) alone or in conjunction with phenylacetaldehyde (PAA). The addition of PAA did not result in higher captures of ECB males. The cone traps caught more ECB females and males and proved to be more accurate in moth detection.The largest cone-shaped traps were the most effective over the Traptest® model in capturing ECB, Silver Y and Syrphidae.

Catture con fenilacetaldeide di *Ostrinia nubilalis* (Hb.), *Autographa gamma* (L.) e Sirfidi: efficacia di diversi tipi di trappola.

RIASSUNTO

Tre tipi diversi di trappole a cono e la trappola a colla vischiosa Traptest® sono state confrontate, dal 1990 al 1992, per catturare *Ostrinia nubilalis* (Hb.), *Autographa gamma* (L.) e Sirfidi. Gli inneschi erano: il feromone sessuale di *O. nubilalis* (97:3, *E*:*Z*-11-14Ac) da solo o insieme a fenilacetaldeide. Non si è notato nessun effetto sulle catture di maschi di piralide in seguito all'aggiunta di fenilacetaldeide. Le trappole a cono si sono dimostrate le più efficaci nel catturare maschi e femmine di *O. nubilalis*, di *A. gamma* e di diverse specie di Sirfidi. Le trappole a cono più grandi sono state quelle che hanno consentito di delineare con maggiore precisione le curve di volo di *O. nubilalis* e si sono dimostrate più efficaci, rispetto alle Traptest®, anche per le catture di *A. gamma* e dei Sirfidi.

REFERENCES CITED

BURGIO G., MAINI S., 1991.- Possibilità di difesa biologica contro i principali fitofagi del peperone in coltura protetta.- *Inf.tore Fitopat.*, 41 (11): 44-46.

CANTELO W.W., JACOBSON M., 1979a.- Corn silk volatiles attract many pest species of moths.- *J.Environ.Sci.Health*, 14(8): 695-707.

CANTELO W.W, JACOBSON M., 1979b.- Phenylacetaldehyde attracts moth to bladder flower and to blacklight traps.- *Environ.Entomol.*, 8: 444-447.

DERRICK M.E., VAN DUYN J.W., SORENSON C.E., KENNEDY G.G., 1992.- Effect of pheromone trap placement on capture of male European corn borer (Lepidoptera: Pyralidae) in three North Carolina crops. - *Environ. Entomol.*, 21: 240-246.

DURANT J. A., MANLEY D.G., CARDÉ R. T., 1986.- Monitoring of the European corn borer (Lepidoptera: Pyralidae) in South Carolina using pheromone traps.- *J. Econ. Entomol.*, 79: 1539-1543.

FLETCHER-HOWELL G., FERRO D.N., BUTKEWICH S., 1983.- Pheromone and blacklight trap monitoring of adult European corn borer (Lepidoptera: Pyralidae) in Western Massachusetts. - *Environ. Entomol.*, 12: 531-534.

HAYNES K. F., ZHAO J.Z, LATIF A., 1991.- Identification of floral compounds from *Abelia grandiflora* that stimulate upwind flight in Cabbage looper moths.- *J. Chem. Ecol.*, 17: 637-646.

LANDOLT P.J., LENCZEWSKI B., HEATH R.R., 1991.- Lure and toxicant system for the Cabbage looper (Lepidoptera: Noctuidae). - *J. Econ. Entomol.*, 84: 1344-1347.

LEDD D. E., CHIANG H.C., 1984.- European corn borer (Lepidoptera: Pyralidae) infestations: relating captures in pheromone and black-light traps in Southern Minnesota cornfields.- *J. Econ. Entomol.*77: 1445-1448.

KENNEDY G.B., ANDERSON T.E., 1980.- European corn borer trapping in North Carolina with various sex pheromone component blends.-*J.Econ.Entomol.*, 73: 642-646.

MAINI S., BURGIO G., 1989.- Lotta biologica contro *Ostrinia nubilalis* (Hb.) (Lepidoptera, Pyralidae) su peperone in coltura protetta.- *Boll.Ist.Ent."G.Grandi"Univ.Bologna*, 44: 23-36.

MAINI S., BURGIO G., 1990.- Influence of trap design and phenylacetaldehyde upon field capture of male and female *Ostrinia nubilalis* (Hb.) (Lepidoptera Pyralidae) and other moths.- *Boll. Ist. Ent. "G. Grandi" Univ. Bologna*, 45: 157-165.

MAINI S., BURGIO G., 1993.- Relazione fra infestazione e catture di adulti di *Ostrinia nubilalis* (Hb.) in trappole a feromone sessuale e fenilacetaldeide, su peperone sotto tunnel.- *Boll. Ist. Ent. "G. Grandi" Univ. Bologna*, 48: 101-107.

MCLEOD D.G.R., STARRATT A.N., 1978.- Some factors influencing pheromone trap catches of the European corn borer, *Ostrinia nubilalis* (Lepidoptera: Pyralidae).- *Can.Entomol.*, 110: 51-55.

OLOUMI-SADEGHI H., SHOWERS W.B., REED G.L., 1975.- European corn borer: lack of synchrony of attraction to sex pheromone and capture in light traps.- *J.Econ. Entomol.*, 68: 663-667.

ROYER L., MCNEIL J., 1992.- Evidence of male sex pheromone in the European corn borer, *Ostrinia nubilalis* (Hübner) (Lepidoptera: Pyralidae).- *Can. Ent.*, 124: 113-116.

THOMPSON D.C., CAPINERA J.L., PILCHER S.D., 1987.- Comparison of an aerial water-pan pheromone traps with traditional trapping techniques for the Europeean corn borer (Lepidoptera: Pyralidae).- *Environ. Entomol.*, 16: 154-158.

WEBER D. C., FERRO D. N., 1992.- Nontarget Noctuids complicate integrated pest management monitoring of sweet corn with pheromone traps in Massachusetts.-*J. Econ. Entomol.*, 84: 1364-1369.

WEBSTER R.P., CHARLTON R.E., SCHAL C., CARDÉ R.T., 1986.- High-efficiency pheromone trap for the European corn borer (Lepidoptera: Pyralidae).- *J.Econ. Entomol.*, 79: 1139-1142.

ZANDIGIACOMO P., GREATTI M., BARBATTINI R., 1993.- *Ostrinia nubilalis* (Hb.) (Lepidoptera Pyralidae) su mais in Friuli. VI. Catture di maschi con diversi tipi di trappole a feromoni sessuali.- *Frustula entomol.*, n.s., 16: 33-40.