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Attractant Performance of a Synthetic Sex Pheromone for *Zeuzera pyrina* L. (Lep. Cossidae) (*)

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Introduction

The Leopard moth *Zeuzera pyrina* L. (Lep. Cossidae) is a harmful insect to many forest species as well as such fruit crops as apple, pear, plum, cherry and olive. Its larvae begin by boring into shoots and gradually spread as they develop into branches throughout the entire plant, eventually causing the tree to whither and die. Control is very problematic because the larvae live inside the branches and the egg-laying period lasts about four months.

Although three compounds have been identified in female abdominal-tip extracts (Tonini *et al.*, 1986; Frerot *et al.* , 1986), the field-trial results recorded for several pheromone blends have been less than satisfactory (Castellari, 1986). Encouraging data have been found for the compound E2, Z13 − 18: Ac (95%)+ E3, Z13 − 18: Ac (5%), a blend that was originally developed to attract *Synanthedon tipuliformis* (Cl.) (Lep. Sesiidae) and also found useful for *Z. pyrina* (Audemard, personal communication). Thus, field tests have been under way since 1988 to determine the latter's attractant performance (Pasqualini *et al.*, 1990) for use in mass trapping (Morteza, 1988).

Materials and methods

Year 1988. Comparative trials testing two traps and two dispensers were set up in eight apple and pear orchards. The traps were Mastrap L(R) (funnel type: max. 18 cm and min. 3 cm diameter, length 20.5 cm, lid diameter 27.5 cm and 12 cm between lid and widest funnel rim) and the Traptest(R) (with

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(1) The authors contributed to this study in equal measure.

glue)([2]); the polyethylene dispenser was developed by the Instituut voor Plante-ziektenkundig Onderzoek([3]) and the rubber one by the Istituto G. Donegani, and were baited with E2, Z13 − 18: Ac (95%) + E3, Z13 − 18: Ac (5%) at a dose of 1 mg.

Year 1989. The trials were continued with the technical assitance of the research staff of the Integrated Pest Management Project of the Emilia-Romagna Region. The same pheromone blend at the same dose was used to bait the polyethylene dispensers that were deployed this time in 106 orchards. Trap comparison was also continued: 45 farms had the funnel and 61 the glue trap; 19 orchards had both. The parameters recorded included orchard cultivar, age, rootstock and training system as well as the percentage of infested plants.

Year 1990. Only the glue trap was tested this year and, in addition to the preceeding year's parameters, the effect of trap height on the capture rate was also recorded. The traps were deployed in 88 farms at three heights: low (about 1.5 m) in 80 farms, high (2.5 m) in 74, and over-canopy (about one-half metre above tree tops, begun in mid-July) in 26; both the high and low traps were deployed simultaneously in 67 orchards and all three in 16.

Kept in the field from June to October in all test years, the traps were spaced 40-80 metres from one another and monitored once a week. Analyis of variance (ANOVA) using a randomized-block designe was used in processing test data; the orchards were considered a block. The data were transformed in log (x + 1) for uniformity of variance and the means separated by the Student Neuman Keuls (SNK) test.

Results

Dispenser. Figure I shows the results for the dispensers. The evident greater number of captures for the polyethylene as against the rubber dispenser is likely due to the former's better and wider range of attractant blend distribution.

Trap. Figure I also presents the funnel and glue trap data, the latter scoring a higher capture rate in 1988 and 1989. The results show that the fourfold higher rate in 1989 was the largest margin of difference ($P<0.01$).

Trap Position. Figure II shows that the rate of captures improves markedly, with trap height. In fact in 1990 both for apple and pear the percentage of orchards with captures was greather as trap height increases. This same pattern is also evinced for the average capture rates (Fig. III).

The analysis of variance, which was applied only to the data for the simultaneous deployment of all three trap types in the same orchard, shows the results for the captures from mid-July on (Fig. IV): all the differences are significant

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([2]) Both traps were developed by the Istituto Guido Donegani at Novara, Italy.

([3]) Instituut voor Planteziektendkundig Onderzoek (IPO), Wageningen, the Netherlands.

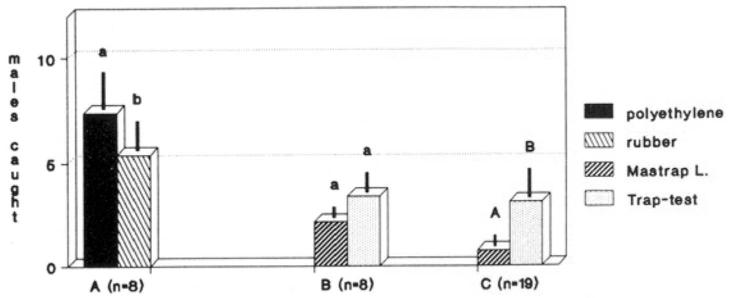

Fig. I - A: Comparison of rubber and plastic dispenser, 1988 (Traptest). B and C: Comparison of Traptest and Mastrap L, 1988 and 1989. The values reported are average yearly captures per trap. Small virgules indicate standard errors. Different letters differ significantly: upper case at P<0.01, lower case at P<0.05.

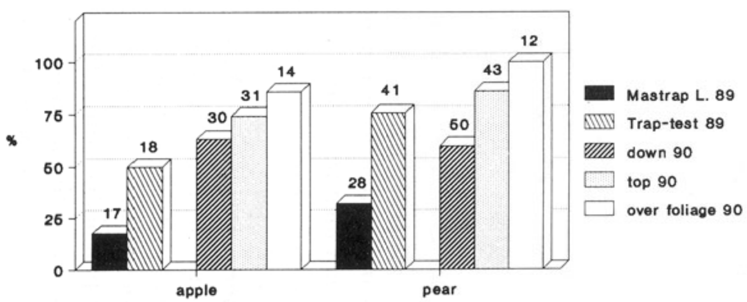

Fig. II - Trap capture rates (%) per host plant and per position. The number of cases is shown above each column.

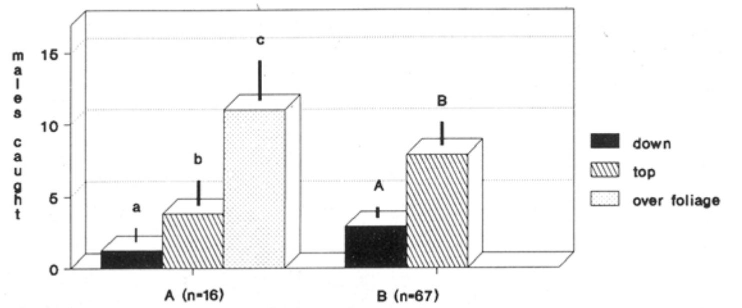

Fig. IV - Comparison of trap (Mastrap) deployment position. A: All three positions deployed simultaneously in the same orchard. B: High and low traps simultaneously. The values reported are average yearly captures per trap. Small virgules indicate standard errors. Different letters differ significantly: upper case at P<0.01, lower case at P<0.05.

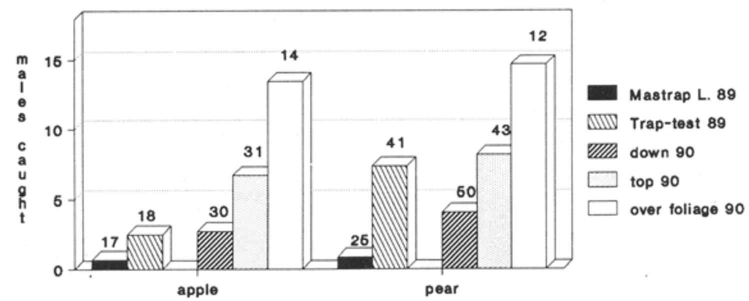

Fig. III - Average yearly captures per trap, per host plant and per position. The number of cases is shown above each column.

(P<0.05). The same figure also includes the average capture rate for the high and low traps deployed in the same orchards from the beginning of the trial (June). Using the average capture rate for the high traps (7.9 adults) makes it possible to estimate a 23.7 average rate for the over-canopy traps had they been deployed from the start of the trial.

Orchard Parameters. Infestation severity was similar for all the parameters considered, i.e. species, rootstock, training system, age and plant height. Figure IV, which has the average capture breakdown for each of the two species (*supra*), also indicates a tendency towards a higher capture rate in pear than in apple. Figure V shows the influence of rootstock: the captures were higher in the orchards with dwarfing as opposed to seedling rootstocks irrespective of trap type and position. By contrast, the data in figure VI seem to indicate that no clear relationship exists between training system and captures. Figure VII, which shows the relationship between age and captures, clearly indicates the decline in capture number in orchards older than 5 years.

Figure VIII reports the capture rate as a function of plant height. The decline in catch number is evident in trees over 2 metres tall and as plant height increases in the classes above 2 metres, limited though this latter is to the high and low traps only. However, since trap position to plant was not constant, it is noteworthy how the capture rate varied along with trap and plant heights (Fig. IX): the higher this ratio, i.e. the higher the trap height with respect to the plant, the higher the capture number.

Clearly the various orchard parameters are intercorrelated, making it impossible to determine whether a decline in catches is due to a single factor or a combination thereof. Yet it is possible to delineate an orchard model in which captures were higher: a young orchard with short trees of a not very compact growth habit. In other words, it would appear that the males are better able to detect the source of the attractant in orchards characterized by those features promoting the lure's diffusion range.

Infestation. Infestation severity, as measured by percentage of trees infested, is reported in figure X: note how the capture rate tends to decline or remain the same as infestation increases, except for the over-canopy traps. One explaination might be that the dispenser is affected by the competition from the females in the tree as a function of trap position (height). Indeed, captures by the low and high traps drop as the attack becomes more severe whereas they rise for the over-canopy traps, though not proportionally, as the percentage of infested plants rises.

Emergence. Figure XI shows emergence patterns based on capture data in 15 orchards that had both the high and low traps deployed from early June to late September. As reported by others (De Giovanni, 1968; Arias and Calderon, 1973; Deseö and Kovacs, 1973; Castellari, 1986), initial emergence can probably be pinpointed within the last half of May and the end of emergence, which also accords with our observations, in the last half of September.

The emergence pattern differed for high and low traps: it was more or less

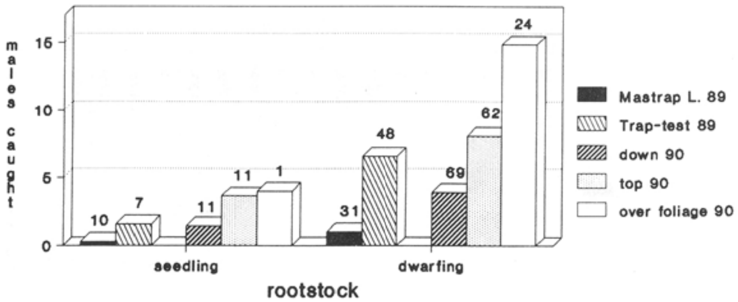

Fig. V - Comparison of average yearly captures per trap in orchards with seedling and dwarfing rootstock. The number of cases is shown above each column.

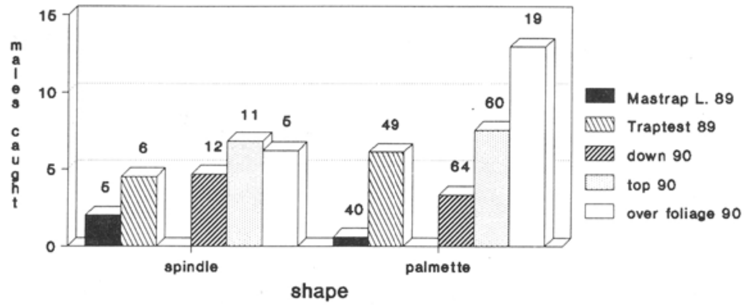

Fig. VI - The relationship between average yearly captures per trap and training system. The number of cases is shown above each column.

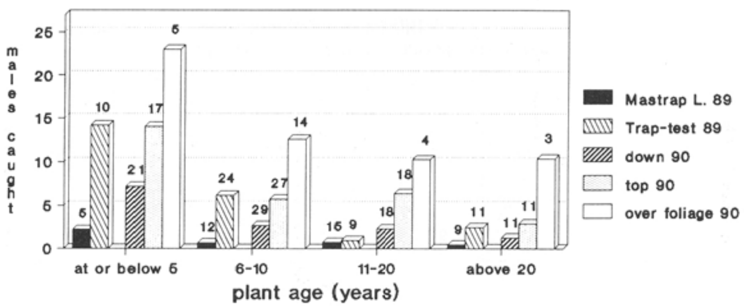

Fig. VII - Average yearly captures per trap compared to tree age. The number of cases is shown above each column.

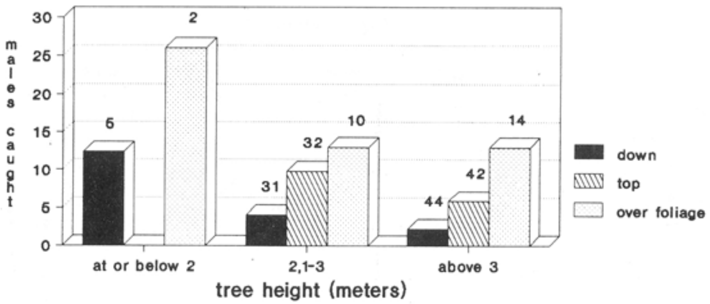

Fig. VIII - Average yearly captures per trap in orchards of varying tree height. The number of cases is shown above each column.

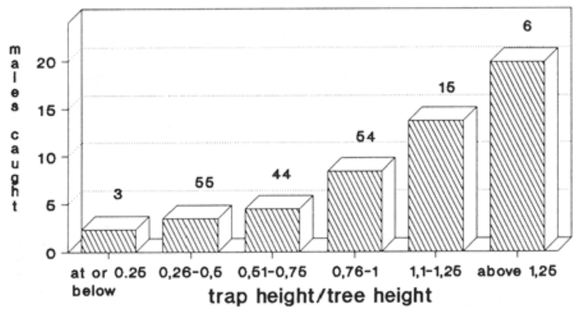

Fig. IX - Average yearly captures per trap as per the varying ratio of trap height to tree height. The number of cases is shown above each column.

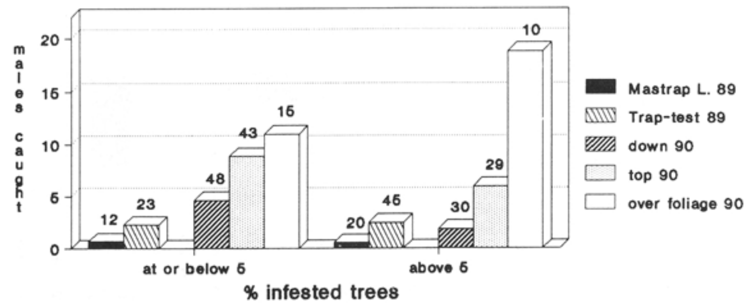

Fig. X - Average yearly captures per trap in orchards of varying infestation severity. The number of cases is shown above each column.

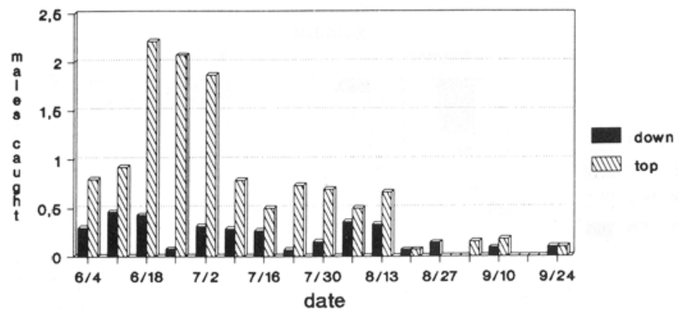

Fig. XI - Capture rates in 15 orchards deploying simultaneously both high and low traps.

steady for the low but showed a peak, also in accord with the authors cited above, spanning the last ten days of June and the first ten of July for the high. That no peak was recorded for the low traps may be due in all likelihood to a decline in capture effectiveness at a time when females are present in maximum number. Also confirmed is the enhanced performance of the pheromone in high traps.

Conclusions

The pheromone blend employed proved to be a satisfactory lure, although it is evident that further research to enhance its performance is necessary for practical field application. Tests to optimize blend concentration, composition and component proportions as well as to compare the attractant lure of virgin moths and pheromone are needed.

The plastic dispenser proved more effective than the rubber one, as did the glue as opposed to the funnel trap. In this latter case, however, there is much room for improvement (specific tests have in fact been set up to determine the most effective trap shape and size).

Trap position *vis à vis* the plant appears to play a very important role. The best results were recorded by the over-canopy (about half a metre above) traps. This may imply a condition of enhanced competitiveness of the trap as compared to females *in situ*, i.e. that it is easier for males to locate the traps in that position, but also a lower competition from females. Yet it can generally be assumed that those orchard features contributing to enhancing the range of the attractant blend, and hence in improving source identification by males, tend to promote increased capture rates. The findings of the preliminary investigations can thus be considered as encouraging, for they supply further elements with which to pursue research into the practical application of mass trapping.

SUMMARY

A sex-attractant pheromone, the synthetic compound E2, Z13 − 18: Ac (95%) + E3, Z13 − 18: Ac (5%), was tested in the mass trapping of *Zeuzera pyrina* L. (Lep. Cossidae) males from 1988 to 1990 in numerous apple and pear orchards. The trials included performance studies of a funnel against a glue trap, of a polyethylene plastic against a rubber dispenser and of trap position with respect to plant height, as well as the investigation of given orchard features and their effects on capture rates.

The findings show that the pheromone blend performed satisfactorily as lure, that the glue trap and plastic dispenser are the more effective, and that the over-canopy (about half a metre) trap deployment resulted in higher capture rates than the other two positions tested. It was also found that several of the examined orchard traits influence capture rate, thus leading to the assumption that those orchard features contributing to enhancing the range of the attractant blend, and hence in improving source identification by males, tend to promote increased capture rates.

Attrattività di un feromone sessuale di sintesi per *Zeuzera pyrina* L. (Lep., Cossidae)

RIASSUNTO

Dal 1988 al 1990 sono state condotte, su numerosi frutteti di Melo e Pero, alcune indagini sull'attrattività di un feromone sessuale per la cattura dei maschi di *Zeuzera pyrina* L. (Lep.,

Cossidae). Tutte le prove sono state impostate utilizzando la miscela feromonica composta da 1 mg di E2, Z13 — 18: Ac (95%) + E3, Z13 — 18: Ac (5%). Le indagini condotte hanno preso in esame l'efficacia di due tipi di trappola (ad imbuto e a colla) e quella di due tipi di erogatori (in polietilene e in gomma), la posizione della trappola rispetto alle piante e, inoltre, sono state valutate alcune caratteristiche dei frutteti e la loro influenza sull'entità delle catture.

I risultati ottenuti hanno messo in evidenza che la miscela feromonica è attrattiva, che la trappola più efficace è stata quella a colla e che il dispenser migliore è stato quello in polietilene. E' inoltre risultato evidente che le trappole collocate circa mezzo metro sopra la chioma catturano di più rispetto a quelle sistemate ad altezze minori. Anche alcune caratteristiche del frutteto (portinnesto, età delle piante, specie frutticola, ecc.) influenzano l'entità delle catture. Ciò porta ad ipotizzare che tutte le condizioni che rendono possibile una migliore diffusione del feromone, e pertanto una più facile individuazione della fonte di emissione da parte dei maschi, favoriscono l'incremento delle catture.

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