Appl. Ent. Phytopath.
Vol. 73, No. 2, March 2006

Efficiency of pheromone baited traps for monitoring of the European corn borer *Ostrinia nubilalis* (Lep.: Crambidae) in Mazandaran province

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ABSTRACT

Pheromone baited sticky traps are used as a monitoring tool for the survey of the European corn borer (ECB) populations in Iran. However, they fail to provide any valuable information to agricultural authorities. This is possibly due either to a wrong formulation of the pheromone lure for local moth populations or to the sticky trap design itself. This trap design is generally considered as poorly efficient against the ECB moth. In this paper, we (1) investigate the pheromone type of Iranian ECB females by means of gas-chromatography and gas-chromatography coupled to mass spectrometry and (2) we compare the efficiency of the delta sticky-trap *versus* a home-made wire mesh cone trap in a field test. Pheromone analyses of 14 individual females clearly showed that their pheromone composition is similar to the pheromone of the ECB *Z* strain feeding on corn in France, i.e. *Z*11-14:OAc as major component and *E*11-14:OAc and 14:OAc as minor components present on the gland surface. This trapping experiment showed that home-made wire mesh cone traps are more efficient

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than sticky traps (respectively 258 males caught *versus* 1) and confirmed that a pheromone lure releasing a *Z* type pheromone is an efficient attractant for ECB males from the Iranian population feeding on corn.

Key words: European Corn Borer, pest monitoring, pheromone baited trap, wire mesh cone trap, sticky trap.

Introduction

The European Corn borer, *Ostrinia nubilalis* Hübner (1796), is a major pest of corn in Iran where the moth population is controlled either by means of a massive release of the oophagous parasitoid wasp *Trichogramma* sp. or by an application of insecticide. However, both the biological agent and the insecticide molecules target a specific instar of the pest. *Trichogramma* females kill ECB eggs -and only eggs- by parasiting them, while insecticides mainly kill neonate larvae as older larvae gets inaccessible to the insecticide by boring into the host plant stem. As a result, the treatment efficiency is dependant on the right timing between the treatment application date and the ECB developmental stage. An accurate adult-ECB flight survey is therefore necessary to ensure the efficiency of the control strategy. Sex pheromone baited traps are good candidates to play such a role. The sex pheromone emitted by ECB females to attract the males has been identified in the United States and Europe as a blend of *Z* and *E*-11-tetradecenyl acetate, *Z*11-14:OAc and *E*11-14:OAc. Within the species, two pheromone strains have been described: a "*Z* strain" (also called the "*Z* race") in which females release and males respond to a blend with 97% *Z*11-14:OAc and 3% *E*11-14:OAc (Klun *et al.*, 1973; Kochansky *et al.*, 1975) and an "*E* strain" that uses the opposite blend made of 96% to 99% *E*11-14:OAc and 4% to 1% *Z*11-14:OAc (Klun *et al.*, 1973; Carde & Roelofs, 1978). Iranian agriculture authorities have planed field trapping of ECB males with both blends but the capture levels were too low to describe accurately the flight curve of adults ECB and to be able to estimate the flight peak date (A. Espahbodi, unpublished data). Moreover, Asgary (1994) assumes that the *Ostrinia* species which is present in Iran belongs to an *Ostrinia nubilalis* sub-species referred to as *Ostrinia nubilalis persica*. This brings up the possibility that ECB population in Iran could have a different pheromone composition and thus it could explain why males are not caught with classical *Z* or *E* pheromones lures in this area.

In order to understand the difficulties experienced previously with ECB field trapping in Iran, we analysed the pheromone of individual ECB females by means of gas chromatography and gas chromatography coupled to mass spectrometry. We also compared male captures in

delta sticky traps *versus* captures in wire mesh cone traps (WMC-traps). Webster *et al.* (1986), Maini & Burgio (1990) and Bartels & Huchison (1998) already showed that wire mesh cone traps are more efficient than sticky traps in the United States and Europe. Based on Pelozuelo (2004) description that only about 6% of attracted males are caught in delta sticky trap design, we tested the hypothesis that low captures of ECB males could rather be due to trap design than to low efficiency of the pheromone lure to attract male insects.

Material and methods

Female sex pheromone identification:

1- Insects: ECB were collected as 5th instar larvae in corn stalk in the Mazandaran province (Sari region). Larvae were sent to the "Phytopharmacie et Médiateurs chimiques" research unit in France and completed their life cycle on a corn-based artificial diet (Poitout & Bues, 1970). The sexes were separated as pupae. Newly emerged females were kept individually in plastic containers supplied with water under rearing room conditions: 16:8h L:D, T =24°C ± 2, R. H.= 60 % ± 10. Two to five day-old females were used for sex pheromone collection within the last three hours of scotophase, during their calling period.

2- Pheromone collection: Pheromones were collected by SPME as described by Frérot *et al.* (1997). The pheromone gland was extruded by a gentle pressure on the abdomen and kept in this position with metallic forceps. A Supelco SPME fibre (65 µm Carbowax^{TM}-Divinylbenzene), previously cleaned by thermal desorption (5 min in the GC-injector at 240°C), was gently rubbed on the pheromone gland for 4 min at room temperature. Care was taken to avoid contact with scales and anal droplets. Then each fibre was either directly analysed or wrapped in an aluminium foil and stored at –20°C until analysis.

3- Pheromone analysis: The chemical components of the sex pheromone were identified via gas chromatography (GC) for seven females and gas chromatography coupled to mass spectrometry (GC-MS) for 10 females.

GC procedure: A Varian 3400 gas chromatograph equipped with a split-splitless injector and a polar column RtX Wax (RESTEK, 30 m, 0.32 mm ID, 0.5 µm df) was used. The components adsorbed onto the SPME fibre were subjected to thermal desorption for 2 min. in the injector heated to 250°C. The column temperature was programmed to increase from 50°C to 100°C at a rate of 15°C min^{-1} then to 245°C at 5°C min^{-1}; helium at a pressure of 11 psi was the carrier gas.

GC-MS procedure: A Varian 3400 gas chromatograph equipped with a SPI injector and coupled to a Saturn II mass spectrometer (ion trap type) was used. The column was an

apolar column MDN-S (SUPELCO, 30 m, 0.32 mm ID, 0.25 µm df). Both polar and apolar column can be used for the successful identification of the *Z* and *E* tetradecenyl isomers. Temperature conditions were as follows: injector temperature 250°C, initial column temperature 50°C during 1 min, then temperature increased to 300°C at a 8°C min^{-1} rate. Desorbtion duration in the injector was 2 min and helium at a pressure of 11 psi was the carrier gas.

Compounds were identified by comparison of retention times (gas chromatography) and mass spectra (mass spectrometry) of the natural compounds with those of synthetic reference samples. In order to allow an easy comparison between pheromone blends whatever their number of components, the ratio between the different components are given as (*Z*:*E*)/*X* with *Z*=percentage of *Z*11-14:OAc related to the total quantity of *Z* plus *E*11-14:OAc, *E*=percentage of *E*11-14:OAc related to the total quantity of *Z* plus *E*11-14:OAc, *X*= ratio of the considered component related to a total amount of *Z* plus *E*11-14:OAc arbitrary fixed as 100.

Field trapping: Delta sticky traps versus Wire mesh cone traps:

1) Traps description: Delta sticky-traps were provided by NPP Calliope (Noguère, France) and were 28 cm long, 20 cm large and 11 cm high (fig. 1).

Wire mesh cone traps were home-made following the indications of figure 1.

2) Trapping site and trap placement: One delta sticky-trap and one WMC-trap were set up in three sites (i.e. 3 replicates). Traps were placed in a grassy border, close to a corn field and at least 50 m apart from each other. Delta sticky-traps were hung about 40 cm above the ground level and WMC-traps were set with the pheromone caps 10 cm below the grass canopy, as indicated by Mason *et al.* (1997) for optimum ECB capture. The 3 trapping sites were located in Iran, in the Mazandaran province (Sari region). The maximum distance between sites was about 20 km. Trapping took place from July 7th 2003 to August 10th 2003 and traps were checked on an average 4-day basis intervals (max. 7 days, min. 2 days) to count and remove ECB males.

3) Pheromone lures. Pheromone lures were red septa loaded with a synthetic blend containing *Z* and *E*11-14:OAc in the 97:3 ratio, purchased from Biosystem (France). These lures are specifically formulated for attracting *Z* strain. Pheromone lures were replaced once, on July 20th 2003.