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# SOME ASPECTS OF THE BIOLOGY OF THE EUROPEAN CORN BORER (*OSTRINIA NUBILALIS* HBN.) ON SWEET CORN

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**Abstract:** In the climatic conditions of Lower Silesia, Poland the European corn borer lays eggs on sweet corn during 3–5 week period between the 3rd decade of June and the 2nd decade of August. The eggs are laid on leaves L1 to L8 of main and lateral stems of the plants. Caterpillars start to hatch at the beginning of July, but in 1998–2000 a massive hatching was observed only in the 2nd and in the 3rd decade of July, whereas in 2001 – in the 3rd decade of this month and in the 1st decade of August. Larvae are capable of migrating between plant rows on the soil surface, which was observed in 1998–2000 from the end of July till the end of October. Most caterpillars migrated in the 2nd and in the 3rd decade of August and in the first days of September. The cob damage by caterpillars ranged between 31 and 46%. Delayed harvest caused a substantial increase in damage.

**Key words**: sweet corn, European corn borer, egg laying, larval migration, cob damage

## INTRODUCTION

Sweet corn has becomes increasingly popular in Poland in the recent years. The overall area on which the crop is grown is estimated at 3.000 ha (Waligóra et al. 1998; Kunicki 2000). Although the soil and climatic conditions of Poland are suitable for the plant, the dietary value of the vegetable is still neglected. The average consumption of the sweet corn in Poland does not exceed 0.05 kg per year (Waligóra et al. 1998). Some important agronomic knowledge concerning the crop is lacking, including information on the main pest and pathogen management (Dubas 1996). Among herbivores found on sweet corn the European corn borer (ECB) (*Ostrinia nubilalis* Hbn.) is the key pest, as it is known to feed on the cobs and inside them. In some regions of Poland the proportion of cobs damaged by the feeding caterpillars may be as high as 50% (Mazurek and Hurej 1999). As all research on ECB accom-

plished so far in Poland has been focused on crops grown for grain or for animal fodder, the biology of the pest on the sweet corn is still poorly understood.

The aim of this study was to estimate the extent of damage caused by the pest on sweet corn, as well as to identify the elements of ECB biology important for its successful management within the crop.

## MATERIALS AND METHODS

The study was carried out at Kobierzyce, 20 km south of Wrocław (Lower Silesia, Poland), in the fields of the Plant Breeding Station "Nasiona Kobierzyc S.A.", in 1998–2001. The sweet corn cultivar Trophy F1 was used.

The biological observations of the ECB were made on plots of 289 $m^2$ size (85.0 × 3.4 m). Plants to be scanned for the pest were chosen and labeled in June each year. In 1998 a hundred plants were labeled and monitored at 4 sites within a plot (25 plants per site). In 1999–2001 only 75 labeled plants were monitored at 3 sites within a plot. The observations were continued till the end of August each year. All plant leaves on the main stem were scanned, as well as the leaves on the lateral shoots. The following parameters were recorded:

- number of egg batches and the number of individual eggs in a batch,
- distribution of the egg batches on plants (laid on the main stem; on the lateral shoots; on individual leaves),
- number of the empty egg shells within a batch.

As all the egg batches found were marked individually and, as such, were identified by their unique numbers, they were also scanned for empty egg shells at each observation date. The number of empty shells recorded during the previous observation was always subtracted from the overall number of empty shells found during the current observation, so that the actual increase in the number of the hatched eggs could be traced weekly.

To record the migration dynamics of the ECB larvae, the tubes of corrugated cardboard were used in 1998–2000. They were made of the cardboard squares of 25 cm side length, rolled tightly in such direction that the "tunnels" in the material were exposed at each end, and tied with a cotton string. In mid-July a hundred tubes were placed between plant rows (3 tubes in every second inter-row) and then replaced weekly with new tubes, till the end of October. The numbers of ECB caterpillars which had entered the collected tubes during the preceding week were then recorded.

To estimate the damage caused by the pest, a hundred cobs were collected short before harvest from a number of consecutive plants in 3 adjacent rows. The number of damaged cobs was recorded. Cobs were classified as damaged when a larva was found in them and also when there were only superficial signs of feeding of the pest on the grain, because material having either kind of damage is rejected by food industry.

In 1999–2001, since mid-July till the first decade of September, 50 cobs were collected weekly from the same plots and the proportion of the damaged cobs was recorded using the same criteria. The latter observations lasted until the end of the

third week after the optimal harvest time (2nd/3rd decade of August), which allowed the cob damage dynamics description.

## RESULTS

### Egg laying and hatching dynamics

First eggs on sweet corn in 1998 were found on June the 29th and the maximum egg laying was observed on July the 7th (Tab. 1). The last egg batches laid, recorded that year, were found on July the 29th. In 1998, 365 eggs in 33 batches were laid. First empty egg shells were recorded on plants on July the 3rd and most of the eggs hatched between July the 7th and the 21st. On July the 21st, 153 new empty shells were found on the monitored plants (Tab. 1). The overall number of empty shells

Table 1. Number of eggs, egg batches and empty egg shells of *Ostrinia nubilalis* on the sweet corn. Kobierzyce 1998–2001

| 1998 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Observation date | 29.6 | 1.07 | 3.7 | 7.7 | 9.7 | 13.7 | 21.7 | 29.7 | 4.8 | Total: |
| Eggs | 47 | 95 | 22 | 99 | 34 | 20 | 32 | 16 | 0 | 365 |
| Egg batches | 5 | 7 | 2 | 8 | 3 | 2 | 4 | 2 | 0 | 33 |
| Empty egg shells | 0 | 0 | 8 | 6 | 54 | 66 | 153 | 36 | 24 | 347 |
| Smpty egg shells cumulative: | | | | | | | | | | unhatched: |
| 1) # | 0 | 0 | 8 | 14 | 68 | 134 | 287 | 323 | 347 | 18 |
| 2)% of all laid eggs | – | – | 2.2 | 3.8 | 18.6 | 36.7 | 78.6 | 88.5 | 95.0 | 5.0 |
| 1999 | | | | | | | | | | |
| Observation date | 29.6 | 2.7 | 6.7 | 9.7 | 14.7 | 17.7 | 20.7 | 25.7 | 28.7 | Total: |
| Eggs | 18 | 66 | 99 | 0 | 44 | 22 | 7 | 5 | 0 | 261 |
| Egg batches | 1 | 6 | 7 | 0 | 5 | 2 | 1 | 1 | 0 | 23 |
| Empty egg shells | 0 | 0 | 30 | 61 | 70 | 20 | 24 | 18 | 11 | 234 |
| Empty egg shells cumulative: | | | | | | | | | | unhatched: |
| 1) # | 0 | 0 | 30 | 91 | 161 | 181 | 205 | 223 | 234 | 27 |
| 2)% of all laid eggs | – | – | 11.5 | 34.9 | 61.7 | 69.3 | 78.5 | 85.4 | 89.7 | 10.3 |
| 2000 | | | | | | | | | | |
| Observation date | 21.6 | 27.6 | 1.7 | 4.7 | 11.7 | 15.7 | 18.7 | 22.7 | 29.7 | Total: |
| Eggs | 16 | 78 | 0 | 45 | 20 | 54 | 19 | 0 | 11 | 243 |
| Egg batches | 1 | 5 | 0 | 3 | 2 | 3 | 1 | 0 | 1 | 16 |
| Empty egg shells | 0 | 0 | 23 | 60 | 43 | 0 | 52 | 20 | 34 | 232 |
| Empty egg shells cumulative: | | | | | | | | | | unhatched: |
| 1) # | 0 | 0 | 23 | 83 | 126 | 126 | 178 | 198 | 232 | 11 |
| 2)% of all laid eggs | – | – | 9.5 | 34.2 | 51.9 | 51.9 | 73.3 | 81.5 | 95.5 | 4.5 |
| 2001 | | | | | | | | | | |
| Observation date | 11.7 | 18.7 | 25.7 | 30.7 | 3.8 | 9.8 | 17.8 | 20.8 | | Total: |
| Eggs | 8 | 22 | 58 | 82 | 87 | 31 | 8 | 0 | | 296 |
| Egg batches | 2 | 2 | 3 | 3 | 4 | 2 | 1 | 0 | | 16 |
| Empty egg shells | 0 | 8 | 22 | 5 | 53 | 113 | 56 | 39 | | 296 |
| Empty egg shells cumulative: | | | | | | | | | | unhatched: |
| 1) # | 0 | 8 | 30 | 35 | 88 | 201 | 257 | 296 | | 0 |
| 2)% of all laid eggs | – | 2.7 | 10.1 | 11.8 | 29.7 | 67.9 | 86.8 | 100 | | – |

found since the beginning of the observations until July the 21st summed up to 287, which means that nearly 79% of the laid eggs hatched till that date. The last empty egg shels hatched on August the 4th.

In 1999, the egg laying of ECB started on June 29th and continued until July 25th, with its maximum, 99 eggs, on July the 6th (Tab. 1). During the 1999 growing season, 261 eggs in 23 batches were laid. First larvae hatched on July the 6th, one week after the first laid eggs were found. The number of hatching larvae increased until July the 14th, when the highest number of new empty shells (70) was found on the corn plants. Much as in 1998, almost 79% of the eggs hatched until July the 20th.

In 2000, the eggs were laid since June the 21st till July the 29th (Tab. 1). The number of laid eggs was high at two first observations (21 and 27 June), than drop to 0 on 1 July and recovered on 4 July. The similar decrease was observed on 22 July, that is, at the end of female laying activity in the season. In 2000, 243 eggs in 16 batches were laid. As the egg laying, the larvae hatching was also irregular. The first empty shells were noticed on 1 July, and the last ones – on July the 29th. The greatest number of newly hatched eggs was recorded on July the 4th ( 60). On July the 22nd, 81.5% of the laid eggs had been hatched (198 empty shells).

The years 1998–2000 demonstrate an apparent similarity in respect to the dynamics of ECB egg hatching. In every one of the seasons the approximately 80% of the laid eggs hatched about July the 20th, i.e. 22, 21 or 31 days (25 days on average) after the first egg batches were found on plants, respectively. In these years the proportion of unhatched eggs varied between 4.5 and 10.3% (2000 and 1999, respectively).

Egg laying in 2001 began late, when compared to the three previous years. The first egg batches were noticed only on July the 11th, but till August the 17th (Tab. 1). In this year 296 eggs in 16 batches were laid on the labeled plants, which was slightly more than in the two preceding seasons, 1999 and 2000, but much less than in 1998. The first empty egg shells were recorded on July the 18th, and the last ones on August the 20th. The maximum number of the empty shells (113) was recorded on August the 9th. Till that day nearly 68% of all the laid eggs (201 of 296) were hatched. 2001 was exceptional in one respect: all 296 eggs laid on the labeled plants hatched.

### Distribution of the egg batches on plants

Of all the 365 eggs laid on the labeled plants in 1998, 45,9% were laid on main stems, most of them on leaves L2-L5 (Tab. 2). Maximum number of eggs were laid on leaf L2. Egg batches on lateral shoots were more scattered, as they were found on leaves L1-L6, with the maximum number on leaf L3. Still, of all the eggs recorded from the plants` lateral shoots, 80% were laid on leaves L3, L4 and L5.

In 1999, 43% of the eggs were laid on the main stems (Tab. 2). They were recorded on leaves L2-L8 and the largest batches were found on L5. Of all the 112 eggs laid on main stems 72% were found on leaves L5-L7. Opposite to that, eggs laid on lateral shoots were rather evenly distributed on leaves L1-L8. Their maxi-

Table 2. Egg batches distribution on different parts on the sweet corn plants. Kobierzyce 1999–2001

| Leaf number | 1998 | | | | 1999 | | | | 2000 | | | | 2001 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | main stems | | lateral shoots | | main stems | | lateral shoots | | main stems | | lateral shoots | | main stems | | lateral shoots | |
| | egg no | %* | egg no | % | egg no | % | egg no | % | egg no | % | egg no | % | egg no | % | egg no | % |
| L1 | 0 | 0 | 18 | 4,9 | 0 | 0 | 22 | 8,4 | 0 | 0 | 17 | 7,0 | 0 | 0 | 0 | 0 |
| L2 | 67 | 18,3 | 16 | 4,4 | 9 | 3,4 | 38 | 14,5 | 0 | 0 | 78 | 32,1 | 0 | 0 | 31 | 10,5 |
| L3 | 29 | 7,9 | 59 | 16,1 | 11 | 4,2 | 22 | 8,4 | 0 | 0 | 62 | 25,5 | 21 | 7,1 | 57 | 19,2 |
| L4 | 41 | 11,2 | 44 | 12,0 | 4 | 1,6 | 12 | 4,6 | 11 | 4,5 | 38 | 15,6 | 26 | 8,8 | 33 | 11,2 |
| L5 | 31 | 8,5 | 57 | 15,6 | 42 | 16,1 | 5 | 1,9 | 18 | 7,5 | 0 | 0 | 34 | 11,5 | 42 | 14,2 |
| L6 | 0 | 0 | 4 | 1,1 | 13 | 5,0 | 27 | 10,4 | 0 | 0 | 0 | 0 | 44 | 14,8 | 0 | 0 |
| L7 | 0 | 0 | 0 | 0 | 26 | 10,0 | 5 | 1,9 | 19 | 7,8 | 0 | 0 | 8 | 2,7 | 0 | 0 |
| L8 | 0 | 0 | 0 | 0 | 7 | 2,7 | 18 | 6,9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| S | 168 | 45,9 | 198 | 54,1 | 112 | 43,0 | 149 | 57,0 | 48 | 19,8 | 195 | 80,2 | 133 | 44,9 | 163 | 55,1 |

*percentage of the total no of eggs laid on the main stems as well as on lateral shoots

mum number, making up 25,5% of the total number found on lateral shoots, was noticed on L2.

In 2000, the majority of ECB eggs (80.2%) were laid on the lower leaves of lateral shoots (Tab. 2). They were found exclusively on leaves L1-L4, with the maximum number, 78, recorded on L2. Less than 20% of all eggs were laid on the main stems of sweet corn plants. They were clustered on the younger, higher leaves, i.e. L4, L5 and L7. No eggs were found on any other leaves of the plants` main stems.

In 2001, nearly 45% of ECB eggs were laid on main stems and around 55% on lateral shoots of the corn plants (Tab. 2). On stems eggs were laid on leaves L3-L7, with the maximum number, 44, on L6, whereas on the lateral shoots they were laid on leaves L2-L5, with maximum number, 57, on L3.

As it was presented, in all years of our study ECB laid more eggs on lateral shoots than on main stems (more than 80% in 2000 and 8–14% in other years). On lateral shoots eggs were usually laid on leaves L2-L5 while on main stems slightly higher, leaves L3-L6.

### Migration of larvae

In the course of our study it has been demonstrated that larvae of *Ostrinia nubilalis* are capable of migrating on the soil surface between plant rows during the growing season. No information about such behaviour of the pest has been found in literature so far. In 1998 the migration was observed since the beginning of August till mid October (Fig. 1). The maximum number of caterpillars, 59, was found in the cardboard tubes on August 31st.

In 1999, larvae were migrating approximately at the same period as in previous year. They maximum number in tubes, 62, was noticed on the 14th September.

The intensity of caterpillars migration observed in 2000 was clearly lower than in two previous years and it also did not last as long as in 1998 and 1999. The larvae

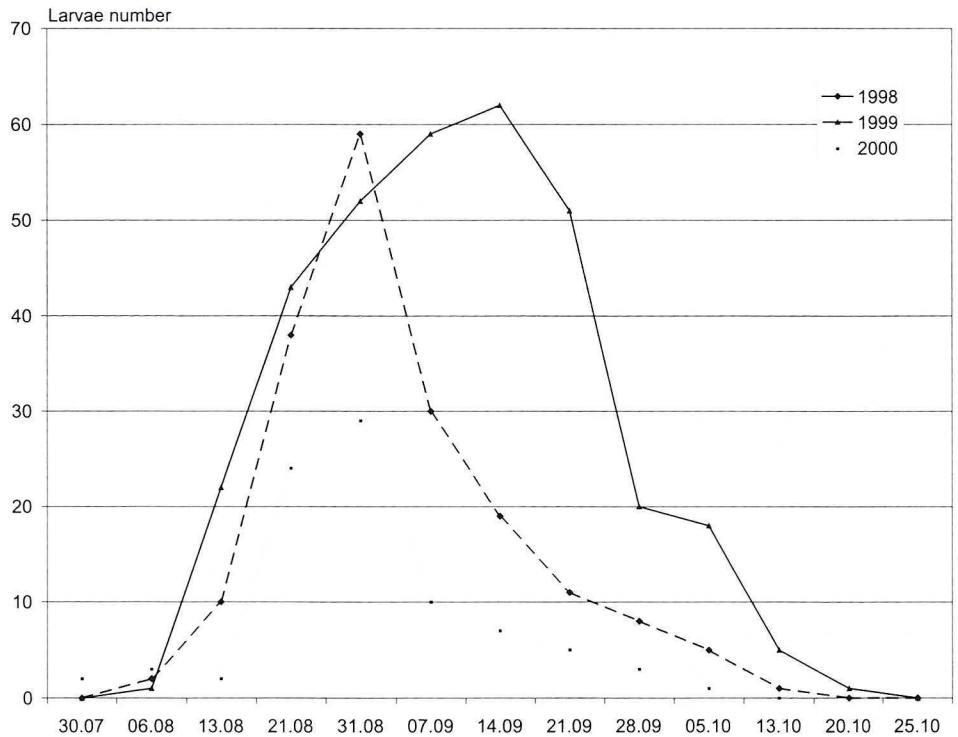


Fig. 1. Migration dynamics of ECB larvae, Kobierzyce 1998–2000

were migrating between the beginning of August and the end of September, with the maximum catch, 29, on August 31th.

## The cob damage caused by ECB

The observed cob damage at the optimal harvest time (2nd/3rd decade of August) varied from 31% in 2000 to 46% in 1999. In 1998 and 2001, the percentage of the damaged cobs was 34 and 43, respectively.

Table 3. The dynamics of cob damage by ECB larvae, Kobierzyce 1999–2001

| 1999 | | | 2000 | | | 2001 | | |
|---|---|---|---|---|---|---|---|---|
| Date | damaged cobs # | damaged cobs%* | date | damaged cobs # | damaged cobs%* | date | damaged cobs # | damaged cobs%* |
| 27.07 | 2 | 4 | 27.07 | 0 | 0 | 25.07 | 0 | 0 |
| 03.08 | 10 | 20 | 01.08 | 2 | 4 | 30.07 | 2 | 4 |
| 13.08 | 16 | 32 | 08.08 | 4 | 8 | 06.08 | 3 | 6 |
| 19.08 | 22 | 44 | 17.08 | 10 | 20 | 13.08 | 8 | 16 |
| 26.08 | 27 | 54 | 25.08 | 12 | 24 | 20.08 | 22 | 44 |
| 03.09 | 31 | 62 | 31.08 | 24 | 48 | 27.08 | 30 | 60 |
| 10.09 | 35 | 70 | 05.09 | 30 | 60 | 03.09 | 35 | 70 |

*percentage of the total number (50) of cobs monitored weekly for the symptoms of larvae feeding

The dynamics of damage caused by ECB larvae was investigated only in 1999–2001. First symptoms of caterpillar feeding on the cobs were usually noticed in the last days of July or at the beginning of August (Tab. 3). At that time, in two of the three years of our study the damage did not exceed 4%, but in 1999 it was as high as 20%. The proportion of damaged cobs increased until the last analysis done in the first decade of September. It has been demonstrated that leaving the cobs on plants approximately 3 weeks after the optimal harvest time results in an extensive damage towards the end of the season. In 2000, and both in 1999 and 2001, 60 or 70% of the cobs were severely damaged in the first decade of September.

## CONCLUSIONS

1. *Ostrinia nubilalis* Hbn. may lay its eggs on the sweet corn plants since the 3rd decade of June till the end of the 2nd decade of August. The laying may last 3–5 weeks.
2. Caterpillars begin to hatch at the beginning of July, but the hatching usually takes place in the 2nd and the 3rd decade of the month (in 1998–2000) or in the 3rd decade of July and the 1st decade of August (2001).
3. Most of the eggs are laid on lateral shoots, most frequently on the leaves L2-L5. The eggs laid on the main stems are generally placed slightly higher, on leaves L3-L6.
4. The study demonstrated that the larvae of *Ostrinia nubilalis* are capable of migrating on the soil surface between plant rows during the growing season. The migration takes place in August, September and October, with most caterpillars migrating in the 2nd and the 3rd decade of August and in the first days of September.
5. The damage, observed at Kobierzyce for the cultivar Trophy F1 at its optimal harvesting time, varied from 31 to 46% of the harvested cobs. Delayed harvest may result in a nearly two-fold increase of the cob damage.

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## POLISH SUMMARY

### WYBRANE ELEMENTY Z BIOLOGII OMACNICY PROSOWIANKI (*OSTRINIA NUBILALIS* HBN.) NA KUKURYDZY CUKROWEJ

W warunkach klimatycznych Dolnego Śląska omacnica prosowianka składa jaja na kukurydzy cukrowej w ciągu 3–5 tygodni tj. w zależności od roku od 3 dekady czerwca do 2 dekady sierpnia. Jaja na pędzie głównym oraz na pędach bocznych składane są na liściach od L1 do L8. Larwy rozpoczynają wylęg z jaj na początku lipca. W latach 1998–2000 masowy wylęg obserwowano w 2 i 3 dekadzie lipca natomiast w 2001 później tj. w 3 dekadzie tego miesiąca i w 1 dekadzie sierpnia. Larwy omacnicy prosowianki mają zdolność migracji po powierzchni gleby pomiędzy roślinami kukurydzy. Migracja odbywa się od końca lipca do końca października, z maksimum w 2 i 3 dekadzie sierpnia i 1 dekadzie września. Procent uszkodzonych kolb wahał się od 31 do 46 a opóźnienie zbioru powodowało znaczny wzrost uszkodzeń.