Voltinism of the European corn borer, *Ostrinia nubilalis* Hbn., in Poland

ĽUDOVÍT CAGÁŇ[1], GRAYŹNA SOBOTA[2], BEATA GABRYŠ[2] and CZESLAW KANIA[2†]

[1]Slovak University of Agriculture in Nitra – Department of Plant Protection, Nitra, Slovak Republic;
[2]Agricultural University in Wroclaw – Department of Agricultural Entomology, Wroclaw, Poland

Abstract

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From 1992 to 1996 the voltinism of the European corn borer, *Ostrinia nubilalis* Hbn., was investigated in Poland. During the study, over 6000 larvae were collected in maize stalks in autumn. In 1994, pupal cases were observed in stalks. This indicated the development of second generation adults of the pest. Pupal cases were not found in other years of the study. The difference between 1994 and the other years was found when the degree-days accumulation at base 10°C was calculated for the periods between July 1 and July 19 (daylight 15 hrs 58 min), or July 29 (daylight 15 hrs 32 min). These values were highest in 1994 and reached 246.5°C, or 414.0°C respectively. The results indicate that degree-days accumulation during the whole year is not responsible for the development of the second generation. It appears that high temperatures in July (not only at the beginning, but also at the end) influenced the development of the second generation of *O. nubilalis* in Poland. Average July daily temperatures in 1994 were extremely high (24.5°C). Such temperatures can allow a small partial development of the second generation of *O. nubilalis* at a relatively cold location like Wroclaw in Poland with a standard annual mean temperature of 8.3°C.

Key words: *Ostrinia nubilalis*; European corn borer; voltinism; diapause; photoperiod

The European corn borer, *Ostrinia nubilalis* Hbn., is univoltine in Poland (KANIA 1961). Until 1939 (with its borders at that time) *O. nubilalis* occured only in the Stanislawow and Tarnopol regions (RUSZKOWSKI 1933). During 1956–1959 the pest appeared at very high numbers in maize fields in the vicinity of Wroclaw (KANIA 1961).

The population near Wroclaw decreased in 1960 and during the sixties (KANIA 1971). In 1969 and 1970 the occurrence of *O. nubilalis* in Poland was low (STUDZINSKI, JUSZCZAK 1972).

Our investigation in the region of Wroclaw showed that damage caused by *O. nubilalis* increased during 1992–1996. In 1994 we also found remnants of pupae of the pest in maize plants. The annual mean temperature in the region of Wroclaw is 8.3°C (KANIA 1962). In this paper we describe the climatic conditions which allowed the development of the second pest generation at such a cold location.

MATERIALS AND METHODS

In the autumns 1992–1996 maize stalks were analysed for European corn borer diapausing larvae and remnants of pupae. Field populations of the pest were examined at the location Kobierzice in the region of Wroclaw.

Degree-days accumulation (base 10°C) was calculated for the periods between the beginning of the year and July 19, between the beginning of the year and July 31, and during the whole year. Daily mean air temperatures 2 m above ground were used for computation.

The degree-days accumulation from the beginning of the year (the number of degrees above the threshold temperature 10°C occurring during each 24 h period) were compared for the period when the incidence of diapause probably occurred.

Temperature data were obtained from the Meteorology Station at Wroclaw-Pawlowice.

RESULTS

During 1992–1996, altogether 6123 larvae were collected in maize stalks (895 larvae in 1992, 413 in 1993, 1265 in 1994, 640 in 1995, and 2610 larvae in 1996). In 1994 four remnants of pupae were found. This indicated the development of second generation adults.

Degree-days accumulation between the beginning of the year and July 19 (the date when daylight decreases to 15 hrs

Table 1. Number of degree-days between July 1 and July 19 (DD_{10}July 1–19), July 29 (DD_{10}July 1–29) or July 31 (DD_{10}July 1–31). Mean daily temperatures in July (T_{aver}July). Number of degree-days between the beginning of the year and July 19 (DD_{10}-July 19), July 29 (DD_{10}-July 29), July 31 (DD_{10}-July 31) or the end of the year (DD_{10}-year) – Wroclaw-Pawlowice 1992–1996

	1992	1993	1994	1995	1996
DD_{10}July 01–19	180.3	105.8	246.5	211.4	131.6
DD_{10}July 01–29	273.4	162.3	414.0	321.9	210.9
DD_{10}July 01–31	291.0	184.5	448.6	347.7	229.3
T_{aver}July	20.0	16.0	24.5	21.22	17.4
DD_{10}-July 19	581.6	561.6	607.4	541.1	544.6
DD_{10}-July 29	688.7	617.7	774.6	651.6	624.9
DD_{10}-July 31	706.1	640.4	809.5	677.4	643.3
DD_{10}- year	1094.1	942.9	1088.7	1128.2	967.8

58 min) ranged from 541.1°C in 1995 to 607.4°C in 1994. This number reached its highest value in 1994, but the differences between the years were not high (Table 1).

The number of degree-days between the beginning of the year and July 31 (daylight 15 hrs 26 min) was highest in 1994 and reached 809.5°C. In 1993, 1995 and 1996 the number of degree days up to July 31 did not exceed 700°C (Table 1).

The number of degree-days for the whole year was the highest in 1995 with 1128.2°C. Also in 1992 this value was higher than in 1994 (Table 1).

The numbers of degree-days between July 1 and July 19 (daylight 15 hrs 58 min), or July 29 (daylight 15 hrs 32 min) were highest in 1994 and reached 246.5°C, or 414.0°C respectively.

The mean daily temperatures of July in 1994 and in 1995 were extremely high. The differences between the years is shown in Table 1; the mean was 24.5°C in 1994, and 21.2°C in 1995.

DISCUSSION

In 1994, for the first time in Slovakia, pupal cases of *O. nubilalis* were observed in stalks, indicating the development of second generation adults of the pest. Degree-days accumulation during the whole year was 1545.3°C (CAGÁŇ 1998). In the same year the degree-days accumulation at Wroclaw (Poland) was only 1088.7°C, but pupal cases were found in spite of such low number of degree-days. This indicated that degree-days accumulation during the whole year is not responsible for the development of the second pest generation.

In environs of southwest Poland the beginning of the *O. nubilalis* flight occurred usually in the last pentad of June and the first pentad of July (KANIA & MYŠLICKY 1984). A few days after emergence of the moths, egg laying can be expected (CAGÁŇ & BARABÁS 1996). The incubation period of eggs lasts 6.3-6.5 (STIRRETT 1938) or 5–7 days (DULIZIBARIĆ 1966) so that the first *O. nubilalis* larvae in Poland usually emerge at the beginning of July. In 1994, the degree-days accumulation from July 1 to July 19 was 246.5°C. The critical instar when larvae of the *O. nubilalis* start to be less sensitive to diapause induction was 3.3 (ELLSWORTH *et al.* 1989) or 3.1 (HOARD 1994). For development to the 3rd instar the larvae of *O. nubilalis* need about 180 degree-days in field-rearing conditions (KELKER *et al.* 1990). Thus, the temperatures were probably high enough for development of larvae able to escape the diapause incidence. The results from Slovakia (CAGÁŇ 1998) showed that extremely high temperatures can influence the diapause of *O. nubilalis* developing on maize plants in Slovakia, but the population is almost completely univoltine. It appears that high temperatures in July (not only at the beginning but also at the end) influenced the development of the second generation of *O. nubilalis* both in Poland and Slovakia. The mean daily temperature during July 1994 was 24.5°C at Wroclaw and 23.1°C at Nitra. The longer photoperiod at Wroclaw, situated further north than Nitra, even enhanced the bivoltine development of some pest individuals. Higher temperatures are known to influence the photoperiod threshold for diapause expression of *O. nubilalis*. According to LAVIALLE (1988), the critical day-length for induction of diapause was 15 hrs 10 min at a temperature of 25°C, and 14 hrs 45 min at 30°C.

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References

CAGÁŇ Ľ. (1998): Voltinism of the European corn borer, *Ostrinia nubilalis* Hbn., in Slovakia. Plant Protect. Sci., **34**: 81–86.

CAGÁŇ Ľ., BARABÁS L. (1966): Phenology of the European corn borer (*Ostrinia nubilalis* Hbn.) in Slovakia. II. Moth emergence in cages and in action sites, oviposition, damage of leafs and stalks. Pfl.-Schutzberichte, Wien, **56**: 45–60.

DULIZIBARIĆ T. (1966): Mogučnost hemijskog suzbijanja kukuruznog plamenca *Ostrinia (Pyrausta) nubilalis* Hbn. s obzirom na njegovu biologiju, ekologiju i nov načim gajenja kukuruza u Jugoslaviji. Zašt. Bilja, **17**: 1–180.

ELLSWORTH P. C., PATTERSON R. P., BRADLEY J. R., KENNEDY G. G., STINNER R. E. (1989): Developmental consequences of water and temperature in the European corn borer–maize interaction. Entomol. Exp. Appl., **53**: 287–296.

HOARD M. W. (1994): Post-diapause and larval development of the European corn borer, *Ostrinia nubilalis* (Hbn.) (Lepidoptera: Pyralidae), in North Dakota. [PhD. Thesis.] Univ. North Dakota, Department of Entomology.

KANIA C. (1961): Z badań nad omacnica prosowianka – *Pyrausta nubilalis* (Hbn.) na kukurudzy w okolicach Wroclawia w latach 1956–1959. Polskie Pismo Entomol., Ser. B, **23–24**: 165–181.

KANIA C. (1962): Szkodliwa entomofauna kukurudzy obserwowana w okolicach Wroclawia w latach 1956–1959. (cz. I.). Polskie Pismo Entomol., Ser. B, **25–26**: 53–69.

KANIA C. (1971): Some problems from ecology of European corn borer – *Ostrinia nubilalis* (Hbn.) in Poland (Rus.). In: Proc. 13th Int. Congr. Ent., Moskva, Vol. I., Nauka Leningrad: 508–509.

KANIA C., MYŠLICKY M. J. (1984): Some bioecological aspects of European corn borer – *Ostrinia nubilalis* (Hbn.) (Lep., Pyralidae) – moths flight dynamics in a maize field in Poland. In: HÚSKA J. (Ed.) Ved. Práce VÚK v Trnave, Osobitné číslo, Príroda, Bratislava: 111–120.

KELKER D. H., LEE D. A., SPENCE J. R. (1990): Use of standard temperature thresholds and phenological prediction for the European corn borer (*Ostrinia nubilalis* Hbn.) in Alberta. Can. Entomol., **122**: 1247–1258.

LAVIALLE M. (1988): La symétrie des réponses photopériodíques dans l induction et la terminaison de diapause chez *Ostrinia nubilalis* Hbn. (Lep., Pyralidae). J. Appl. Entomol., **105**: 516–524.

RUSZKOWSKI J. W. (1933): Winiki badań nad szkodliwa fauna Polski na podstawie materialów z lat 1919–1930. Roczn. Ochr. Rośl. Cz. B, Warszawa, **1**: 1–89.

STIRRETT G. M. (1938): A field study of the flight, oviposition and establishment period in the life cycle of the European corn borer *Pyrausta nubilalis* Hbn. and the physical factors affecting them. IV. The oviposition and establishment periods. Annual cycle of oviposition. Flight and oviposition. Egg mortality and survival. Larval mortality and survival. Sci. Agric., **18**: 568–585.

STUDZINSKI A., JUSZCZAK M. (1972): Wystepowanie i szkodliwošč chorób i szkodnikov rejestrowanych na jeczmieniu (*Hordeum* L.), kukurudzy (*Zea mays* L.) i koňskim zebie (*Zea mays* ssp. *indentata* Strut.) v Polsce v latach 1969–1970. Biul. Inst. Ochr. Rost., Poznaň, **53**: 133–177.

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Súhrn

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V rokoch 1992–1996 sa sledoval voltinizmus vijačky kukuričnej, *Ostrinia nubilalis* Hbn., v Poľsku. V steblách kukurice bolo spolu nazbieraných viac ako 6000 lariev škodcu. V roku 1994 sa pozorovali v steblách kukurice obaly z kukiel, čo znamená vývin druhej generácie škodcu. Zvyšky kukiel sa nenašli v ostatných rokoch pozorovania. Rozdiel medzi rokom 1994 a inými rokmi sa pozoroval v sume efektívnych teplôt nad 10 °C vypočítaných od začiatku júla do 19. júla (dĺžka dňa 15 h 58 min) alebo do 29. júla (dĺžka dňa 15 h 32 min). Táto hodnota bola najvyššia v roku 1994 keď dosiahla 246.5 °C, resp. 414.0 °C. Výsledky naznačujú, že suma efektívnych teplôt počas roka nemá vplyv na vývin druhej generácie škodcu. Ukázalo sa, že vývin druhej generácie škodcu v Poľsku ovplyvnili vysoké teploty v júli. Priemerné denné teploty v júli 1994 boli extrémne vysoké (24.5 °C). Takéto teploty môžu podporiť vývoj čiastočnej druhej generácie vijačky kukuričnej aj na relatívne chladnej lokalite ako je Wroclaw v Poľsku s obvyklou priemernou ročnou teplotou 8 °C.

Kľúčové slová: *Ostrinia nubilalis* Hbn.; vijačka kukuričná; voltinizmus; diapauza; fotoperióda

Corresponding author:

Doc. Ing. ĽUDOVÍT CAGÁŇ, CSc., Slovenská poľnohospodárska univerzita, Katedra ochrany rastlín, tr. A. Hlinku 2, 949 76 Nitra, Slovenská republika, tel.: + 421 87 65 08 253, fax: + 421 87 74 11 451, e-mail: cagan@afnet.uniag.sk