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Effects of Photoperiod on the Adult Diapause in the Alfalfa Weevil, *Hypera postica* (GYLLENHAL)

(Coleoptera: Curculionidae)

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Abstract : The alfalfa weevil, *Hypera postica* (GYLLENHAL),is the uni-voltine insect and diapause in summer. To make clear the relationship between induction diapause and photoperiodic condition in Japan, the experiments under various photoperiods were conducted. The critical day length was between 12 hr and 12.5 hr. And under the day length longer than this, all adults were induced diapause. When the day length was extended from 8 hr to 14 and 16 hr after emergence, all adults were induced diapause. On the other hand, the day length shorter than 12 hr did not induce diapause except some cases. When the day length was extended from 8 hr to 16 hr after emergence, adults were induced diapause, but the reverse case did not induce diapause. The extension of the day length from 8 hr to 16 hr until 20th day after emergence was affective to induce diapause. Furthermore the result shows that the long-day (16L-8D) photoperiodic condition in the teneral stage of adult induces the diapause of this species.
Key words : alfalfa weevil, *Hypera postica*, diapause, photoperiod, summer diapause, adult diapause

Introduction

The alfalfa weevil, *Hypera postica* (GYLLENHAL), is one of the most serious pest of alfalfa in the world and it distributes in Europe, Russia, West Asia, South Asia, North Africa and North America.

Photoperiod is the most reliable seasonal cue for the control of life cycle in insects (MASAKI, 1984).

In 1982, the occurrence of this weevil was confirmed in Fukuoka and Okinawa Prefectures. It was the first record in Japan. Now, this pest distributes south western part of Japan and they feed *on Medicago* spp. and *Astragalus sinicus*. Recently, the damage against *A. sinicus* that is one of the most important crop for apiculture as resource of honey in Japan is serious in some parts of Kyushu district. As adults and larvae of this species feed on not only leaves but also flower buds, honey that collected by honeybee has been decreased recently.

In North America, many reports on the diapause of the alfalfa weevil have been published for a long time. The critical day length that induces the adult diapause is among 10 and 12 hr and the day length longer than the critical day length induces adult diapause (MADUBUNYI, 1978). When only the egg, or egg to larva, or egg to pupa or egg to adult was reared under 10L-14D, and the respective subsequent developmental stages were transferred to 16-hr photophases, all resulting teneral adults entered diapause (MADUBUNYI, 1978). Hence, BLAND (1971) reported that the stage of larval development is the most sensitive to the diapause inducting photoperiod appears to occur in 4th instar.

In Japan, there are some reports on the life history, host plants and behavior but on the diapause have not been reported to date. The purpose of this paper is to confirm the effects of the photoperiod on the induction of adult diapause that is the important factor to make clear the life history of this weevil in Japan because of its peculiar long dormancy in summer.

Materials and Methods

Insects

H. postica adults were collected in Kita-Kyushu City, Fukuoka Prefecture. They were kept in a plastic container (242 × 307 × 101mm) with fresh alfalfa bouquets under short-day (8L-16D) condition at 20 ℃. The eggs of the first laboratory generation were used for experiments.

Experiment I

Eggs laid in the stem of the alfalfa were kept on wet filter paper in petri dish under 7 different light regimens (8L-16D, 10L-12D, 12L-12D, 12.5L-11.5D, 13L-11D, 14L-10D and 16L-8D) at 20 ℃. After hatching, larvae were transferred to plastic container (242 × 307 × 101mm) with fresh alfalfa bouquets under previous each photoperiod. On the first day following pupa-adult metamorphosis, males and females were randomly selected and paired singly in a small transparent plastic container (67 × 37 × 12.5mm) with fresh alfalfa leaves and a piece of Kimwipe [R] that were changed twice a week. Fifty pairs were checked for feeding and oviposition in each condition. The pairs that laid eggs were removed. This experiment was terminated 15 weeks after emergence.

Experiment II

Adults that were reared under 8L-16D from eggs to emergence were divided into 6 groups. A pair of adult was introduced in the small container in the same way of experiment I in each group. Fifty pairs of adults were used in each group and reared under 6 different photoperiod respectively (8L-16D, 10L-14D, 12L-12D, 13L-11D, 14L-10D and 16L-8D) at 20 ℃. The pairs were checked for feeding and oviposition in each condition. The pairs that laid eggs were removed. This experiment was terminated 15 weeks after emergence.

Experiment III

In this experiment, two groups of this species were reared under different photoperiod before emergence were used. Adults that were reared under short-day (8L-16D) and long-day (16L-8D) from egg to emergence were introduced in a small container in the same way of experiment I. Fifty pairs of adults were used in each two group were kept under short-day (8L-16D) condition after emergence. They were checked for feeding and oviposition in each condition. The pairs that laid eggs were removed. This experiment was terminated 15 weeks after emergence.

Experiment IV

Insects were reared under the photoperiod combined short-day (8L-16D) and long-day (16L-8D) (see Fig. 1) at 20 ℃. Fifty pairs were checked for feeding and oviposition in each condition. The pairs that laid eggs were removed. This experiment was terminated 15 weeks after emergence.

Results

Experiment I

Figure 2 shows the results of this experiment. The pairs that stopped feeding by the end of experiment and were not confirmed oviposition were defined diapausing individuals, and the pairs that were confirmed oviposition by the end of experiment were defined not diapausing. Under 8L-16D, 10L-14D and 12L-12D photoperiod, all pairs of each group were confirmed oviposition. Under 12.5L-11.5D and 13L-11D photoperiod, 2% and 10% of adults were confirmed oviposition respectively. And all pairs under 14L-10D and 16L-8D photoperiod were not confirmed oviposition.

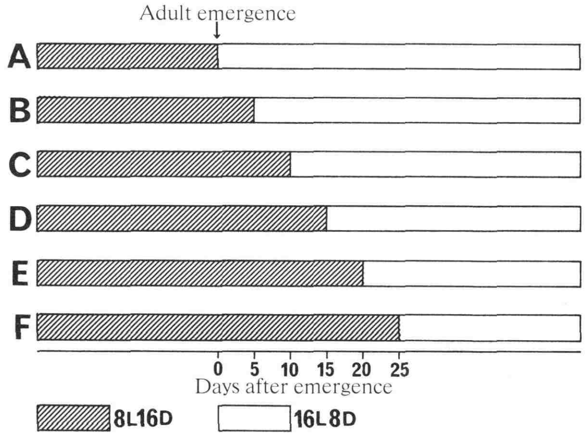

Fig.1 Photoperiod scheme to which *Hypera postica* were exposed at 20 ℃.

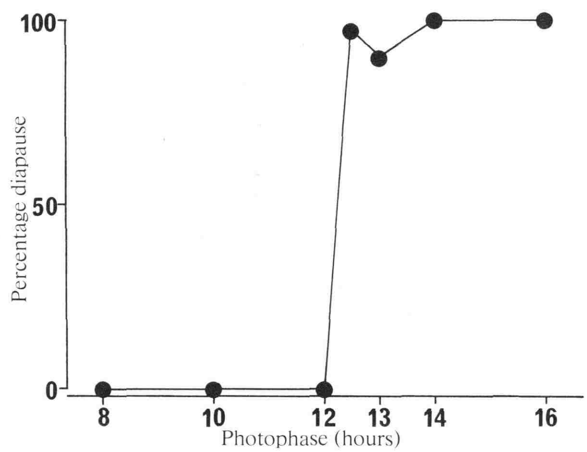

Fig.2 Photoperiodic responce for adult diapause in *Hypera postica.*

Experiment II

The results were shown in Fig. 3 with the results of experiment I. Under 14L-10D and 16L-8D photoperiod all pairs entered diapause. Under 13L-11D condition, the rate of diapause was increase. And under 10L-14D and 12L-12D conditions, the rate of diapausing was about 10%. The shapes of two curves that indicate percentage of diapause were very similar.

Experiment III

The cumulative percentage of females that began to oviposit under two photoperiodic conditions was shown in Fig. 4. All pairs of both groups were confirmed oviposition. The day when the females reared under short-day (8L-16D) transferred from long-day (16L-8D) after emergence that began to oviposit were delayed about 5days compared with reared under constant short-day.

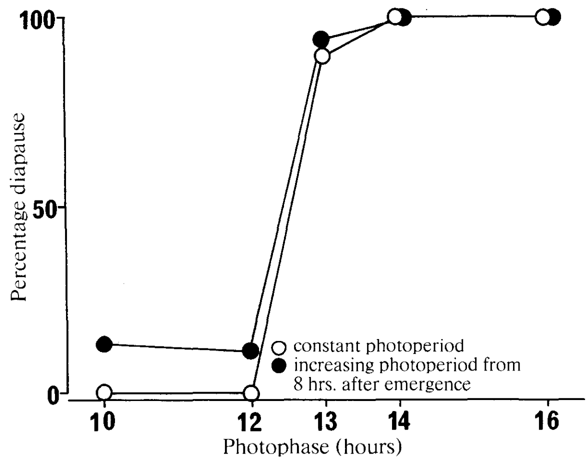

Fig.3 Effect of increasing photoperiod on diapause induction in *Hypera positica.*

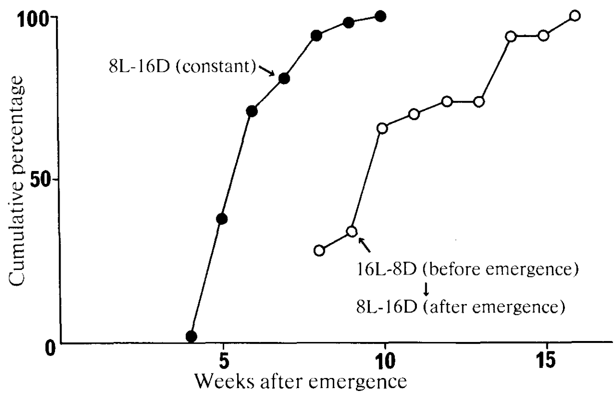

Fig.4 Cumulative percentage of females of *Hypera postica* that began oviposition under different photoperiod.

Experiment IV

The results were shown in Table 1. All the adults that were transferred from 8L-16D to 16L-8D on 0th, 5th, 10th,and 15th day after emergence were considered to be induced diapause. Sixty-two point five percent of the adults that were transferred on 20th day after emergence were considered to be induced diapause. But, all pairs of adults that were transferred on 25th day after emergence confirmed oviposition.

Cumulative percentages of females that began oviposition and the pairs that stopped feeding under different photoperiodic conditions were shown in Fig. 5. The data from the adults that were transferred from 8L-16D to 16L-8D after emergence were shown with the data from previous experiment. The day when the females began to oviposit was mentioned in experiment III. On the other hand, the cumulative curves of the pairs that stopped feeding under constant 16L-8D and transferred from 8L-16D to 16L-8D photoperiod were almost similar.

Table 1. Effects on induction of adult emergence of *Hypera postica* transferred from short-day (8L-16D) to long-day (16L-8D)

	Days after emergence when *H. postica* transferred from short-day to long-day	percentage diapause
A	0	100
B	5	100
C	10	100
D	15	100
E	20	62.5
F	25	0

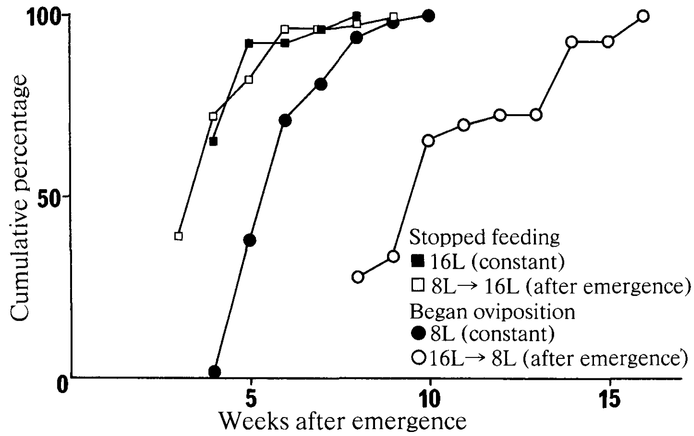

Fig.5 Cumulative percentage of females of *Hypera posica* that began ovipositon and pairs thatstopped feeding under different photoperiod.

Discussion

MADUBUNYI (1978) reported that the critical day length that induces the adult diapause of alfalfa weevil is between 10 hr and 12 hr. In this report the critical day length was between 12 hr and 12.5 hr. There are some reasons in this difference. MADUBUNYI defined the diapause individual that did not oviposit in 5 weeks after emergence. The pre-ovipositional period of this species was varied from 4 to 10 weeks after emergence shown in this experiment or in the report by ROSENTHAL and KOEKLER (1968). The examination for 5 weeks after emergence was not sufficient to determine the non-diapausing individuals. It seems that the insects that would oviposit after 6weeks after emergence were classified as diapausing individuals. The weevils that transferred from 8L-16D to 14L-10D or 16L-8D after emergence entered diapause. On theother hand, some weevils transferred to 10L-14D or 12L-12D enter diapause but all weevils under constant 10L-14D or 12L-12D not enter diapause. From these results, the day length in the adult stage is an important factor to induce adult diapause. To elongate to the day length shorter than the critical day length has an effect to induction the adult diapause. There was a time lag in the cumulative curves of females oviposited under between constant 8L-16D and transferred from 16L-8D to 8L-16D but the shapes were similar. However, there was no time lag between the cumulative curves of pairs that stopped feeding under between constant 16L-8D and transferred from 8L-16D to 16L-8D. It seems that the preparation of sexual maturity is already started by the short day condition before emergence and the adults reared under long day condition before emergence start the preparation of sexual maturity after the sensitive period. These results suggested that the sensitive period to diapause induction was until 15 days after emergence.

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和 文 摘 要

アルファルファタコゾウムシ *Hypera postica* (GYLLENHAL) の成虫休眠を誘起する日長条件

大戸　謙二

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(1) アルファルファタコゾウムシ、*Hypera postica* (GYLLENHAL)の成虫休眠を誘起する臨界日長は、12時間と12.5時間の間にあり、これより長日側で休眠に入ることが明らかとなった。

(2) 羽化後の日長を増加させると、増加後の日長が14時間と16時間の区では(1)の結果と同様に休眠に入った。一方、12時間より短日側ではほとんどの個体で産卵が確認されたが、一部休眠に入ったと考えられる個体が現れた。

(3) 羽化前を8時間日長とし羽化後を16時間日長とした場合、すべて休眠に入り、逆の組み合わせではすべて産卵が認められ非休眠であった。また、羽化後15日目までに8時間から16時間に変化させた区ではすべて休眠し、20日目に変化させた区では62.5%、25日目の区では0%の休眠率であった。

(4) 8時間日長で飼育した区では、平均して30日程度で産卵を開始することから、本種の成虫休眠は、成虫期の中でも特に初期の段階における長日条件によって誘起されることが明らかとなった。また、短日条件から羽化後の日長を増加させることによって、臨界日長より短日側であっても一部の個体に休眠を誘起させる効果のあることが明らかになった。