Effect of P.E. film-mulching on the Damage to Tobacco Seedlings by the 'Dark Grey Cutworm', *Agrotis tokionis* Butler

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ABSTRACT This study was carried out to see what makes the 'dark grey cutworm', *Agrotis tokionis* Butler, inflict less damage in P.E. film-mulched tobacco fields than in nonmulched ones. In field plot experiment, the damage ratio of tobacco seed lings in mulched plots(m) was reduced by 63% compared with that in nonmulched ones(n). The altered environments did not affect the cutworm in mortality, which was confirmed by recovery ratio, location of larvae in soil, and developmental age. But the m/n value and damage ratio in plots of different mulching methods strongly suggest that the P.E. film itself prevent larvae from cutting the plants. Larval mortality was rapidly increased between the end of July and the end of August.

INTRODUCTION

Covering the ridges with transparent polyethylen film has become a common practice in cultivating various crops, such as tobacco, potato, redpepper, and strawberry since it was introduced into tobacco fields in 1960's. It helps plant grow better, especially in early spring, possibly due to its protection of moisture and fertilizer from evaporation and leaching from the soil, respectively. Moreover, it raises soil temperature to make it possible to transplant seedlings early.[2)]

Consequently we can easily assume drastic alterations in temperature, moisture contents, and physical and chemical characteristics in the mulched soil when compared with those in nonmulched soil. These environmental changes would certainly exert influences directly or indirectly upon soil-inhabiting organisms to some degree.

There were some intensive studies on the micrometeorology and heat balance in P.E. film-covered soil[5,6,8)] and abundant references on the repellent effect of mulching materials, on account of reflective surfaces, against white flies or aphids, which were reviewed extensively by Cohen(1982) and Simons(1982). However, no serious study can be found on the effect of P.E. film mulching on the activities of soil insects.

For the 'dark grey cutworm', *Agrotis tokionis* B., it was observed that the insect larvae inflicted less damage to tobacco seedlings in mulched fields than in nonmulched ones.[4)] Therefore, some experiments were carried out to find out why the larvae give less damage to tobacco seedlings in mulched ridges.

MATERIALS AND METHODS

Two field experiments were conducted in 1981 and 1982 at the Agricultural Research Station of Korea Ginseng and Tobacco Research Institute located at Suwon.

1) Decremental effects of P.E. film-mulching on damage to tobacco seedlings by *A. tokionis* larvae in 1981 : Plots with three ridges of 4.5m long and 0.9m wide were arranged with eight replications in each treatment(mulched

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and nonmulched). The plots were encircled with plastic barrier panels 30cm high with 10cm of it burried in the ground to prevent the larvae from migrating to the neighboring plots or crawling out of the plots. On May, 26, thirty 7th instar larvae were introduced into each plot and then it was mulched with polyethylene film(0.02mm thick) for the mulched plot. Tobacco seedlings(54/plot) were transplanted in both treatments 1 day after introducing the larvae. The larvae were those collected in the field and reared individually in the laboratory at room temperature. Soil temperature in depth of 5cm was recorded at every two hours from 10 a.m. to 6 p.m.

2) Comparison of damage ratio with modified-mulching methods in 1982 : All plots with four ridges, 4.5m long and 0.9m wide, were arranged in a randomized block design with three replications. Plastic barrier pannels were buried to encircle the plots. Ten 7th instar cutworms were introduced into each plot. The number of tobacco seedlings cut down by the larvae were counted at field plots with five treatments as follows;

1) Nonmulched ridge(NMR) : Tobacco seedlings were transplanted without mulching after the larvae were introduced within the ridges.

2) Partially mulched ridge(PMR) : Both sides of the ridges were covered with P.E. film(0.02mm thick) but 10cm wide upper part of the ridges remained uncovered where tobacco seedlings were transplanted after the larvae were introduced.

3) Completely mulched ridge(CMR) : The ridges were covered with P.E. film after the larvae were introduced but prior to transplanting tobacco seedlings.

4) Doubly mulched ridge(DMR) : The ridges were covered twice with P.E. film after the larvae were introduced but prior to transplanting tobacco seedlings.

5) Control : Tobacco seedlings were transplanted after the ridges were mulched as in the CMR and the larvae were introduced in the center of the plot.

RESULTS AND DISCUSSION

1) Decremental effects of P.E. film-mulching on damage to tobacco seedlings by the cutworm: The average damage ratio was much lower in the mulched plots than in the nonmulched ones, clearly showing the beneficial effects of mulching(Table 1). On June 15th by which the damage was finished, damage by the 'dark grey cutworm' was reduced by 63.3% in mulched plots compared with that of nonmulched plots. And the c.v. value of the damage ratio of mulched plots were about twice as large as that of nonmulched ones so that feeding tobacco seedlings by the larvae in mulched plots was not considered to be in favorable condition.

The m/n value was the least(0.12) one day after cutworm infestation, and increased with time until the cutworm did not cut the seedlings any longer. This strongly suggests that the reduction in damage was resulted not

Table 1. Beneficial effects of P.E. film-mulching on damage ratio of tobacco seedlings by *A. tokionis* larvae

Date	Damage ratio[a](%) Mulched plot(m)	Damage ratio[a](%) nonmulched plot(n)	m/n
May, 27	1.7±1.2(70.6)[b]	14.1± 4.3(30.5)	0.12
28	7.4±4.3(58.1)	29.9± 4.5(15.1)	0.25
29	10.9±4.5(41.3)	38.7± 7.3(18.9)	0.28
June, 1	16.2±5.2(32.1)	54.2±10.0(18.5)	0.30
4	21.5±4.7(21.9)	63.9±10.1(15.8)	0.34
8	25.2±6.5(25.8)	71.3± 9.3(13.0)	0.35
12	26.4±8.6(32.6)	75.0±11.4(15.2)	0.35
15	28.3±8.7(30.7)	77.0±10.6(13.8)	0.37

[a] Damage ratio = $\frac{\text{No. of plants cut by the larvae}}{\text{Total no. of plants/plot}} \times 100$

[b] Numbers in parentheses in C.V.

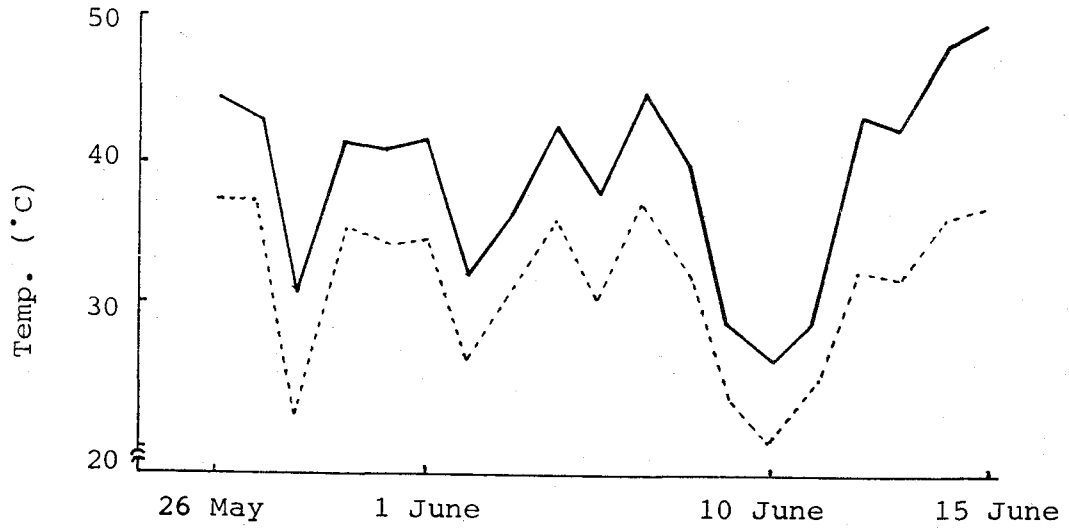

Fig. 1. Fluctuation of daily highest temperatures in soil(5cm deep) of P.E. film-mulched ridge(solid line) and nonmulched ridge(broken line) in 1981.

from environmental differences caused by the the mulching but from P.E. film itself. Otherwise the m/n value should have decreased because altered environments would affect cutworms more as time got by.

In mulched plots, the daily highest temperature in soil (5cm deep) was 5~7°C higher than in nonmulched ones during the damaging period(Fig. 1). At the end of the experimental period in the year of 1981 the temperature gap grew wider becoming over 10°C and the daily highest temperature in mulched plots reached 50°C. This high temperature in mulched soil was supposed to affect the cutworm so as to induce higher mortality or at least make the insects hide in deeper soil during daytime. However, the recovery ratio and depth of insect location were not different between the two treatments. Many of the insects were located within the mulched ridges and also recovered from bare soil between ridges(Table 2). We can assume that once the larvae escaped to outside the P.E. film, it was difficult to climb up to the top of the ridges, where the seedlings were planted, but wandered around and fed weeds between ridges.

Table 2. Effects of P.E. film-mulching on the recovery ratio and behavior of infested *A. tokionis* larval population in tobacco field

Source[a]		Recovery ratio(%)	Depth(cm) of soil where the insects were found	No. of insects recovered from within or between ridges (within/between)
June, 9	M	86.7	4.2±2.3	12/14
	N	86.7	4.5±3.0	—
19	M	73.3	3.5±2.4	8/14
	N	93.3	4.5±2.2	—
July, 23	M	76.7	5.0±3.2	6/17
	N	83.3	5.0±2.5	—
Aug. 28	M	26.7	4.1±2.2	4/6
	N	10.0	4.4±2.8	—
Sept. 8	M	23.3	4.9±1.7	3/4
	N	20.0	4.1±2.1	—
23	M	13.3	4.3±1.9	3/5
	N	36.7	4.4±1.4	—
t		n.s.	n.s.	—

[a] M: mulched plot, N: nonmulched plot

Field populations of the 'dark grey cutworm' enter into summer diapause mostly in mid-June[3] and pupate between late August and early September. Most of the insects recaptured on August 28th were already pupae. However the recovery ratio was dropped to 10~26.7% on August 28th from 76.7~83.3% on July 23rd. This suggests that the mortality

Table 3. Number of feeding days of *A. tokionis* larvae from recaptured day to the incidence of summer diapause

Recaptured day	Source	No. of feeding days	No. of insects
June 9	mulched plot	7.1±1.7	7
	nonmulched plot	7.1±3.5	7
June 19	mulched plot	12.0±2.0	2
	nonmulched plot	6.0	1

of the 'dark grey cutworm' in field would be very high between the end of July and the end of August when the diapausing insect might resume its physiological activity.[3] This phenomenon was also observed later in laboratory with rearing of this insect at room temperature(Kim, unpublished observation).

Some active larvae(not in summer diapause) among the insects recovered on June 9th and June 19th were taken to the laboratory(Table 3). As the number of insects recovered on June 19th were so few we can not take them in consideration. However, the number of insects on June 9th were the same in both plots and the feeding days in the laboratory of the insects from both plots were not different either. Provided that the larvae enter diapause whenever they complete larval development[3], the insects in both plots were not different in developmental age. This tells us, though the larvae in mulched plot cut less tobacco seedlings, they must had fed something else, probably weeds between ridges.

2) Damage ratio with modified mulching methods: The table 4 shows the damage ratio of tobacco seedlings with different mulching and cutworm-infesting methods. Damage ratio was the highest in NMR and the second highest in PMR. The upper part of PMR not covered with P.E. film might let the larvae move freely but the both sides covered would restrict movements of some larvae between ridges so that the damage ratio of PMR became less than that of NMR. Other treatments,

Table 4. Damage to tobacco seedlings by *A. tokionis* larvae with different methods of P.E. film-mulching

Mulching method[a]	Mean damage ratio[b]
NMR	20.8±3.1a[c]
PMR	10.0±3.5b
CMR	7.7±2.0bc
DMR	5.0±2.0c
Control	3.3±1.2c

[a] NMR : Nonmulched ridge
PMR : Partially mulched ridge
CMR : Completely mulched ridge
DMR : Doubly mulched ridge

[b] Damage ratio = $\frac{\text{No. of Plants cut by the larvae}}{\text{Total no. of plants/plot}} \times 100$

[c] $p < 0.05$

CMR, DMR, and control, made no significant difference in damage ratio among themselves. However, their damage ratios, except CMR's, were less than that of PMR. The nonmulched upper part of PMR, which may guarantee the activity of the larvae unless they move down between ridges, looks to be the reason for the difference.

As a result, we could not find any evidence that the P.E. film-mulching affects the cutting potential of the 'dark grey cutworm' through alteration in environments. But the decreasing m/n value and the damage ratio with different mulching methods strongly suggest that the P.E. film impose itself as an obstacle to the larval movements, resulting in less cutting of tobacco seedlings. It was observed in field condition that larvae always changed the direction of their movement whenever they met P.E. film surface.

적 요

P.E. film으로 피복한 포장에서 숫검은밤나방 유충에 의한 담배 피해주율이 낮은 원인을 구명하기 위한 시험에서 다음과 같은 결과를 얻었다.

1. 피해주율은 무피복구(n)에 비해 P.E. film 피복구(m)에서 63% 감소하였다.

2. 피복한 畦 내의 일중 최고 토양온도(5cm 깊이)는 무피복구에 비해 조사기간중 평균 5~7 °C 높았으며 6월 중순에는 50°C까지 이르렀다.

3. 유충의 회수율, 토양내 잠복깊이 및 발육정도 등에서 P.E. film 피복구와 무피복구간에 차이가 없었다.

4. m/n치와 5가지 변형된 피복방법의 결과에 비추어 P.E. film 자체에 의해 숫검은 밤나방 유충의 이동 혹은 먹이탐색활동이 방해를 받는 것으로 생각되었다.

5. 숫검은밤나방유충의 사망율은 7월 하순과 8월하순 사이에 급격히 증가하는 것으로 나타났다.

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