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Short Communication

Electron Beam Irradiation of Immature Stages of Leafminer, *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae)

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Abstract : Immature stages of leafminer, *Liriomyza trifolii* were exposed to electron beams with doses of 0, 100 and 200 Gy. Irradiation for immature stages (eggs, 1st-2nd instar larvae, 3rd instar larvae and pupae) at the 100 Gy and 200 Gy doses could inhibit the adult emergence. The larvae were more tolerant to irradiation than the eggs. The irradiated larvae at 200 Gy continued to feed on leaf tissue after exposure and were allowed to develop into the pupae but not into adults.
Key words : *Liriomyza trifolii*, Agromyzidae, radiation, electron beam, quarantine

Introduction

The American serpentine leafminer, *Liriomyza trifolii* (Burgess), is known as a serious pest in various ornamentals and vegetables. This polyphagous leafminer has been recorded from 25 plant families including Asteraceae, Leguminosae and Solanaceae (Spenser, 1990). The distribution area of the pest has been widespread with the transportation of flower-cuttings and seedlings (Minkenberg, 1988). Moreover, the development of insecticide resistance makes the control difficult.

From the view point of plant quarantine, it is difficult to intercept leafminers at immature stages developing in plant tissues. Yathom et al. (1990) reported the effects of gamma radiation as the alternative treatment of fumigation on the immature stages of *L. trifolii*. Meanwhile, Dohino and Tanabe (1993) suggested the effectiveness of electron beam irradiation as a quarantine treatment for the mites which infest cut flowers. In this study, the effects of electron beam irradiation on the immature stages of *L. trifolii* were examined.

Materials and Methods

1) Irradiation for eggs and larvae

Preparation of infested leaves

Twenty female flies were released in the cage (30 × 30 × 45 cm) that contained 3 kidney bean-seedlings. Each seedling has only the first two true leaves and the cut end of stem was soaked in water placed in bottle. The flies were allowed to lay eggs into the leaves freely for 6 hours. After exposure, the leaves were cut at the petioles and moved to petri-dishes with agar. The cut end was put into agar preventing the leaf from drying (Fig. 1).

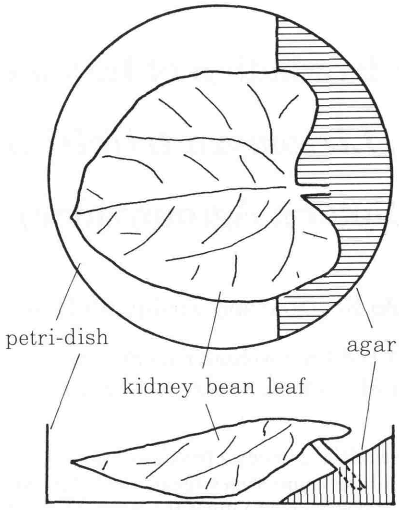

Fig. 1. Kidney bean leaf in petri-dish with agar.

Exposure to electron beam

The eggs, 1st - 2nd instar larvae and 3rd instar larvae in the infested leaves were exposed to electron beams with the doses of 0, 100 and 200 Gy. They corresponded to 1, 3 and 5 day-old after oviposition, respectively. The absorbed dose of irradiation was determined with a RCF dosimeter (FWT-60-00, Far West Technology Inc.) (HAYASHI et al., 1992). Electron beam irradiation was carried out with a Van de Graaff electron accelerator (Nissin High Voltage Co. Ltd., 2.5 MeV, 1.5×10^6 Gy/hr) at the National Food Research Institute. The absorbed dose was controlled by changing the beam current at a conveyer speed of 3.0 m/min. Beam currents were 14.7 μA and 29.4 μA for 100 Gy and 200 Gy, respectively. The irradiation unit was operated at 20 °C and 50 to 60% R.H. Before and after irradiation, the infested leaves were kept in an incubator at 25 °C under 24L:0D conditions. The number of pupae emerging from leaves was recorded everyday. Pupae remaining inside the leaves were taken out on the 12th day after oviposition. The pupae collected from both inside and outside of the leaves were placed in plastic containers and the adult emergence was recorded everyday. These pupae were kept under the same conditions as infested leaves described above.

2) Irradiation for pupae

One day-old pupae after pupation from kidney bean leaves were exposed to electron beams at doses of 0, 100, 200 Gy. Conditions of irradiation were the same as for the eggs and larvae. Before and after irradiation, the pupae were kept in an incubator at 25°C under 24L:0D conditions. The number of adults which emerged was counted everyday.

Results

Tables 1, 2 and 3 show the effects of irradiation on the pupation and emergence of *L. trifolii* irradiated at eggs, 1st - 2nd instar larvae and 3rd instar larvae, respectively.

The eggs irradiated even at 100 Gy could not develop into the pupal stage while 85.2% of the tested eggs was pupated in the control group (Table 1). These irradiated eggs seemed to be killed directly or die immediately after irradiation as there were no mines in the leaves.

The 1st - 2nd instar larvae were more tolerant to irradiation than the eggs since about 60% of the larvae irradiated at 200 Gy reached the pupal stage (Table 2). However, these pupae could not reach the adult stage. Percentage of pupation decreased as the dose increased. On the other hand, the rate of pupae remaining the inside to the outside of the leaves rose with increased doses. In the case of irradiation at the 3rd instar larvae, no adults emerged though the larvae reached the pupal stage (Table 3). Fig. 2 shows that the larval period, especially in the irradiated 1st - 2nd instar larvae, tended to become longer as the dose was increased.

From the pupae irradiated at 100 and 200 Gy, no adults emerged (Table 4). While, more than 60% of the pupae in control could reach the adult stage.

Table 1. Pupation and emergence of *L. trifolii* irradiated at the egg stage (one day after oviposition)

Doses (Gy)	No. of eggs tested[1]	No. of pupae	Pupation[2] (%)	No. of adults	Adult emergence[3] (%)
0	149	127	85.2(4.7)	82	64.6
100	179	0	0	0	0
200	198	0	0	0	0

[1]Values indicate the sum of the numbers of unhatched eggs and dead larvae remaining in the leaves, and pupae.
[2]Values mean "No. of pupae / No. of eggs tested × 100". Value in parenthesis means "No. of pupae remaining in the leaves / No. of eggs tested × 100".
[3]Values mean " No. of adult / No. of pupae × 100".

Table 2. Pupation and emergence of *L. trifolii* irradiated at the stage of 1st-2nd instar larvae (three days after oviposition)

Doses (Gy)	No. of 1st-2nd instar larvae tested[1]	No. of pupae	Pupation[2] (%)	No. of adults	Adult emergence[3] (%)
0	114	105	92.1(3.5)	61	58.1
100	201	146	72.6(7.0)	0	0
200	118	71	60.2(11.0)	0	0

[1] Values indicate the sum of the numbers of dead larvae remaining in the leaves and pupae.
[2]Values mean "No. of pupae / No. of 1st-2nd instar larvae tested × 100". Values in parenthesis mean "No. of pupae remaining in the leaves / No. of 1st-2nd instar larvae tested × 100".
[3]Values mean " No. of adult / No. of pupae × 100".

Table 3. Pupation and emergence of *L. trifolii* irradiated at the stage of 3rd instar larvae (five days after oviposition)

Doses (Gy)	No. of pupae	No. of adults	Adult emergence[1] (%)
0	42	23	54.8
100	67	0	0
200	74	0	0

[1] Values mean " No. of adult / No. of pupae × 100".

Table 4. Emergence of *L. trifolii* irradiated at the pupal stage (one day after pupation)

Doses (Gy)	No. of pupae tested	No. of adults	Adult emergence[1] (%)
0	152	94	61.8
100	148	0	0
200	149	0	0

[1] Values mean " No. of adult / No. of pupae tested × 100".

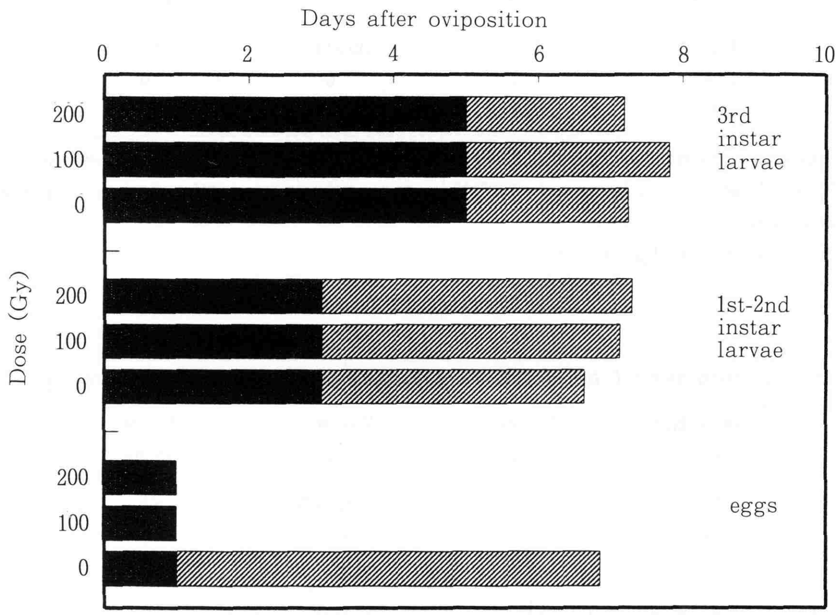

Fig. 2. Effect of irradiation on developmental period.
■ : Period from oviposition to irradiation.
▨ : Period from irradiation to pupation.

Discussion

In these experiments, electron beam irradiation for immature stages of *L. trifolii* at 100 and 200 Gy could inhibit the adult emergence, though the irradiated larvae were allowed to develop into the pupae. It is considered that the effect of irradiation was larger on histolysis and/or histogenesis in the pupae than it was on pupation. When the 1st - 2nd instar larvae were treated even at 200 Gy, they continued to feed on the leaf tissue and caused subsequent damage, which implied that the commercial value of ornamentals and vegetables would deteriorate further after irradiation. Similar studies with the same species irradiated by gamma radiation indicated that the dose of 250 Gy did not prevent further feeding of the 1st instar larvae, but that 500 Gy prevented further feeding (YATHOM et al., 1990).

Only 1 day-old pupae were dealt with in this study, which resulted in inhibition of their adult emergence at 100 and 200 Gy. However, YATHOM et al. (1990) reported that the pupal sensitivity decreased with increasing age in gamma irradiation. Irradiation of elder pupae should be carried out in a way to enable to disinfest the entire pupal stage.

TANABE and DOHINO (1993) reported that chrysanthemum, one of the major host plants of *L. trifolii*, showed severe injuries by electron beam irradiation even at 200 Gy. Meanwhile, YATHOM et al. (1991) suggested that 40 Gy was the minimum dose of gamma radiation which was needed to disinfest the immature stages of *L. trifolii* since the 40 Gy dose prevented the establishment of a new generation and was not injurious to gypsophila flowers. In electron beam irradiation, there seems to be possibilities that the lower dose irradiation inhibits the adult emergence or makes the adult sterile, although it does not prevent larvae feeding. Further studies are expected to estimate the appropriate dose which plants can tolerate and the pest can not.

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和 文 摘 要

マメハモグリバエ *Liriomyza trifolii* (BURGESS) (Diptera: Agromyzidae) の電子線照射について

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マメハモグリバエ *Liriomyza trifolii* の卵，幼虫および蛹に，0，100および200 Gyの電子線照射（2.5 MeV）を行い，その影響を調査した。100 Gyおよび200 Gyの照射では，試験を行った全てのステージ（卵，1－2齢幼虫，3齢幼虫，蛹）で羽化が阻止された。しかし，照射に対する耐性は卵よりも幼虫が高く，照射された幼虫は照射後も植物組織を摂食し，200 Gyでも蛹化するものが見られた。