



**การศึกษาการแข่งขันการผสมพันธุ์ของแมลงวันผลไม้,  
*Bactrocera dorsalis* (Hendel) ที่ฉายรังสีทำหมัน**

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**บทคัดย่อ**

ปัจจัยพื้นฐานที่มีความสำคัญของการควบคุมและกำจัดแมลงโดยเทคนิคการปล่อยแมลงที่เป็นหมันด้วยรังสี คือ การเพาะเลี้ยงและการฉายรังสีทำหมันจะต้องไม่มีผลกระทบต่ออายุและความสามารถในการผสมพันธุ์ของแมลงที่ปล่อยไป แต่การทดลองในห้องปฏิบัติการหลายแห่งพบว่าการฉายรังสีที่ปริมาณรังสีทำให้แมลงเป็นหมันอย่างสมบูรณ์ทำให้แมลงไม่สามารถแข่งขันผสมพันธุ์กับแมลงปกติได้ การทดลองนี้จะศึกษาผลของการฉายรังสีแกมมาทำหมันต่อความสามารถในการแข่งขันการผสมพันธุ์, การสืบพันธุ์และสเปิร์มแมลงวันผลไม้, *Bactrocera dorsalis* (Hendel) ผลการทดลองพบว่าการฉายรังสีเพื่อให้แมลงเป็นหมันอย่างสมบูรณ์ (90 Gy) ทำให้ความสามารถในการแข่งขันการผสมพันธุ์และสเปิร์มลดลง ถึงแม้ว่าความสามารถในการแข่งขันการสืบพันธุ์จะไม่ลดลง เนื่องจากแมลงที่ฉายรังสีเริ่มผสมพันธุ์ได้เร็วกว่าและส่วนใหญ่ตัวเมียจะผสมพันธุ์เพียงครั้งเดียว

**Studies on mating competitiveness of sterile oriental fruit fly,  
*Bactrocera dorsalis* (Hendel)**

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**ABSTRACT**

An essential prerequisite for insect control by the sterile insect technique releasing method is mass rearing and sterilizing that do not have adverse effects on longevity and mating behavior of the released males. But many laboratory studies have shown that males irradiated at the completely sterility dose often could not compete with untreated males in mating. This paper studies the effects of gamma radiation at the sterile dose on mating, sexual and sperm competitiveness of the oriental fruit fly, *Bactrocera dorsalis* (Hendel) under the laboratory condition. It is found that irradiation at the completely sterility dose (90 Gy) had reduced the mating and sperm competition ability of the males. Though the sexual competition was not

## INTRODUCTION

An essential prerequisite for successful application of the sterile insect technique release method to eradicate or control the insect pests is mass rearing and sterilization that do not have adverse effects on longevity and mating behavior of the released males. Many laboratory studies have shown that males irradiated with gamma radiation at the completely sterile dose often could not compete with untreated males in mating although irradiation did not significantly reduce longevity of the males (Economopoulos, 1972). In addition, mass rearing of insects at the constant temperature and using artificial diet for many generation effect on physiological and behavioral characteristics. Kakinohana (1980) reported that mass rearing with artificial diet in laboratory caused the qualitative changes of the melon fly, such as oviposition, sexual maturation, diurnal rhythm of mating, mating competitiveness and dispersal ability in the field. The experiment of Hibino and Iwahashi (1989) showed the difference of mating behavior between mass reared melon fly and wild fly. Iwahashi (1992) showed the results of SIT at Doi Ang Khang, a part of Integrated Control of Fruit Flies which supported by IAEA. Though the number of released flies per month reached 30 millions and the M/U ratio reached 10 or more, the number of wild flies caught from traps did not decreased, so ratio of M/U did not increase. The fault of the control may be occurred because of the low quality of the released flies or the immigration of wild flies. Iwahashi (1993) showed the non-synchronized daily activity pattern with wild flies of the released flies. Mating and sexual competitiveness are the method that can be used as a quality control of the flies to check results from mass rearing, irradiation and transportation. However, the mating and sexual competitiveness data in laboratory is not realized under the field conditions.

This paper studies the effects of gamma radiation at the completely sterile dose on mating, sperm and sexual competitiveness of the oriental fruit fly, *Bactrocera dorsalis* (Hendel) under the laboratory condition.

## MATERIAL AND METHODS

Insects: The oriental fruit fly, *Bactrocera dorsalis* (Hendel) used in this experiment were taken from the mass rearing facility of OAEP (Office of Atomic Energy for Peace). The 2 days before emergence pupae were marked and irradiated with gamma radiation at the dose of 90 Gy at TIC (Thai Irradiation Center). After emergence 2 days, both normal and irradiated flies were sexed

and reared separately in laboratory at temperature  $27 \pm 2$  °c with water and the mixture of sugar and protein yeast hydrolysate. The 4-day-old flies were treated with cool and marked individually with enamel paint pens.

Cages: The 25x25x25 cm. screen cages were used to study the mating and sexual competition of the flies. The plastic containers, with 6 cm. diameter and 10 cm. height, were used to study sperm competition of the flies. Water and the mixture of sugar and protein yeast hydrolysate were provided.

### Experiments

To study the mating and sexual competitiveness tests, the marked flies were put in the cages as shown in Table 1.

Table 1 The combination of normal and irradiated males and females in each treatments

Treatment	Combination		
	Normal male	Irradiated male	Normal female
1	30	0	15
2	20	10	15
3	15	15	15
4	10	20	15
5	0	15	30

After fly releasing, the cages were kept in laboratory at temperature  $27 \pm 2$  °c, under the natural light condition. The number of mating flies were checked and identified every day until none mating. The egg collection by using guava juice stimulation were done twice a week.

To study the sperm competition, the virgin females were mated separately to normal males and to irradiated males after eclosion 10 days. After the successful copulation had occurred, all males were removed the morning after. On the third day after the first copulation, the virgin normal and irradiated males were put into the cages, for the remating of the females with opposite type males from the first mating. The eggs collected from successful remating females were checked hatchability every two days.

## RESULTS AND DISCUSSION

Table 2 shows the number of mating of normal and irradiated males in each treatments and competitiveness values, estimated directly from the number of mating flies ( Teruya and Sukeyama, 1979).

$$C = (i/u) / (I/U)$$

C = competitiveness value

i = number of mated irradiated males      u = number of mated normal males

I = number of irradiated males              U = number of normal males

Table 2 The number of mating of normal and irradiated males and competitiveness values in different ratio of normal and irradiated males

Female	Ratio of I/U	No. of copulation	No. of mated normal male	No. of mated irradiated male	C
N	0:30	9	9	0	
N	10:20	15	12	3	0.50
N	15:15	13	10	3	0.30
N	20:10	16	4	12	1.50
N	30:0	14	0	14	

The result shows that the number of mating normal males was slightly higher than irradiated males ( $C = 0.77 \pm 0.64$ ). The number of mating normal male per irradiated male and competitiveness values at the ratio of irradiated per normal male 10/20, 15/15 and 20/10 when mated with normal females were 12:3, 10:3, 4:12 and 0.5, 0.3, 1.5 respectively. At the higher ratio of irradiated per normal males, competitiveness value was higher.

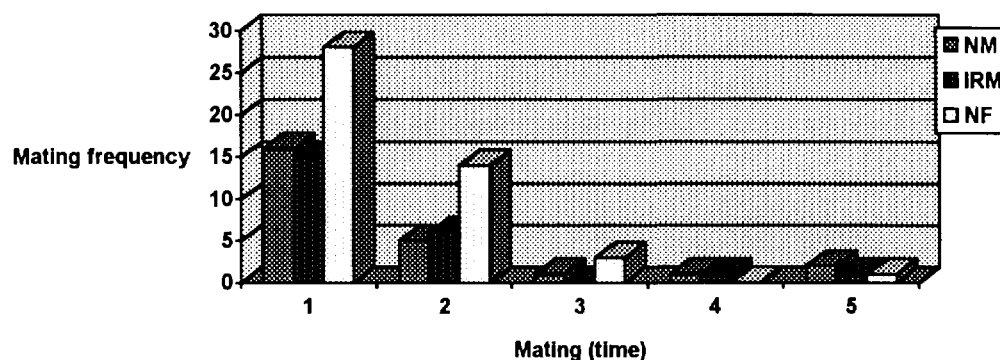


Fig. 1 Mating frequency of normal and irradiated oriental fruit flies

The mating frequency of normal and irradiated males are shown in Fig.1 , that irradiated males could mate more frequency than normal males ( $x_n = 1.44$ ,  $x_{ir} = 1.57$ ) but non significance at level  $p = 0.05$  ( $t = 0.478$ ). The percentage of non- mating of normal and irradiated males were 69.33 and 69.33 % and percentage of normal and irradiated males mated more than 1 time were 9.33 and 10.67 %, while the percentage of mating of normal females more than 1 time was 24 %.

Table 3 The estimation of the sexual competitiveness of sterile *Bactrocera dorsalis*

(Hendel) under laboratory condition

SM	Combination		Total no. of flies	No. of egg examined	% Egg hatch	C
	NM	NF				
0	30	15	45	1017	80.02	
10	20	15	45	2206	32.49	2.93
15	15	15	45	1691	11.74	5.82
20	10	15	45	1673	54.16	0.24
30	0	15	45	1977	0.00	

Note : SM = Sterile males

NM = Normal males

NF = Normal females

The result shows that irradiated males were stronger than normal males ( $C = 3.00 \pm 2.79$ ). At the ratio of normal per irradiated males 20/10, 15/15 and 10/20, the sexual competitiveness values were 2.93, 5.82 and 0.24 respectively. At the ratio of normal per irradiated males 20/10 and 15/15, the sexual competitiveness were higher than the mating competition due to prior mating of irradiated males and the most of females mated only one time. But at the ratio of normal per irradiated male 10/20, the sexual competitiveness was low although the mating competition was not low. It is because the most of females remated with normal flies and the sperms from irradiated males were weaker than those from the normal males (Table 4).

**Table 4.** Mean hatchability and P2 values of eggs laid by the female oriental fruit flies during 30 days after the second mating in double-mating schedules.

Treatment	No. of females	% hatchability	P2	Mean
N	50	80.02		
S	50	0.00		
NS	15	41.06	0.6570	0.5656
SN	22	52.57	0.4869	

Note : N = Females mated with normal males

S = Females mated with sterile males

NS = Females mated with normal and sterile males

SN = Females mated with sterile and normal males

P2 value was calculated by transforming formula of Boorman and Parker (1976) as follow:

$$P = (x-b)/(a-b)$$

where a, b, and x are the hatchability of eggs from mating with a normal male, that from mating with a irradiated male, and that from mating with both normal and irradiated males, respectively. When the second male is normal,  $P_2 = P$ , and when the second male is irradiated,  $P_2 = 1-P$ . Hatchability and P2 values were transformed to arcsin-square roots to normalize them and unweighted means.

The result shows that sperms of the irradiated males were weaker than those of normal males ( $P_2 = 0.5656$ ). However, the result is not different from the melon fly, *Bactrocera cucurbitae* which  $P_2$  is nearly 0.5 (Tsubaki and Sokei, 1988).

These results also indicate that irradiation with the completely sterility dose (90 Gy) had reduced mating and sperm competition ability of the flies. Though the sexual competition was not reduced, due to the earlier mating of the irradiated flies and almost females mate only one time.

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