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【Research report】

東方果實蠅在田間之移動現象【研究報告】

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Abstract

摘要

東方果實蠅之移動受田間之作物相及生育期影響很大，尤以開花及果實成熟期為甚，在寄主及非寄主果園之移動現象差異很大；在鳳梨園 (非寄主) 其飛行距離超過2公里以上，平均為0.94公里，在蓮霧園 (寄主) 其飛行距離最遠僅0.60公里，平均為0.33公里。另試驗中釋放之不孕性成蟲在田間平均存活五週之久，更長者可存活9週。成蟲在田間之移動距離有時很明顯地可看出越飛越遠，但有時卻數週仍停留在原處或某一點徘徊，發生徘徊之場所，多為較隱密且通風不良之樹叢，尤以寄主果園及濃密之竹園，可提供其取食，產卵及停息之場所，發生之蟲數最高。

Key words:

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MOVEMENTS OF ORIENTAL FRUIT FLIES IN THE FIELD

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ABSTRACT

The movements of *Dacus dorsalis* depended on the flora of various plants especially the host plants including their blossom and fruit stage. The dispersive distance of this fiy was different between the host plant and non-host plant areas. The distance of dispersal in the pineapple orchard was more than 2Km, its mean value being 0.94Km; the distance of dispersal in the host plant areas is more than 0.60Km with an average of 0.33Km. From recapture by methyl eugenol trap in the field, the sterile flies could survive up to 9 weeks, and the mean survival duration was 5 weeks in the field. After the marked flies were released in the field, the dispersive distance increased gradually, but sometimes the flies stay around in a certain area for feeding, oviposition and shelter. Bamboo fields are the most favored areas for the fiy's resting. There might be more shelters in the bamboo field than other orchards.

INTRODUCTION

The oriental fruit fly, *Dacus dorsalis* Hendel, is a major insect pest which attacks more than 150 plant species of 38 families, especially citrus fruits, mangoes, peachs, pears, guavas, carambola, wax apples, etc. in Taiwan. (13, 14) The control of oriental fruit flies using the sterile-insect technique and the male attractant of methyl eugenol was initiated from 1975 on this island (9). For the purpose of the field control of this fly, it is necessary to enhance the studies to supplement the ecological data. Two type of adult movements was described (2), the first is "dispersive movement", such adults tend to move frequently; their direction of movement may be oriented in relation to the wind, and they may travel considerable distances in a relatively short time. The environmental changes which initiate these movements are often obscure, but disappearance of fruit from an area is sometimes clearly implicated. Steiner et al (2) reported movement ranging from 25 to 45 miles (including distances up to 40 miles over water) for *D. dorsalis, D. cucurbitae* and *Ceratitis capitata,* and state that large number of flies may move rapidly out of an area fruit supply diminishes. The second type is "non-dispersive movement", adult inhabit an area where ample host fruits are available oviposition. The flies tend to remain in such areas, and their movements are associated with the normal activities of feeding, ovipositing, and mating. They often have a daily periodicity and rarely take the individuals far from their host plants. The tendency for the *Rhagoletis pomonella* to remain with the orchard, distribution of adults within the orchard was influenced by tree variety and the presence or absence of fruit (10). Adults do some feeding in areas adjacent to orchards and that some of these return to the orchard (10). The dispersal behavior of melon flies was reported in Okinawa, (7) the distribution of released male adults of the melon fly was not the same in three directions from the release point, the mean dispersal distance ranged from 50 m to 90 m. Another group of melon flies released at a different point, where the environment was less favourable to melon flies, showed a wider range of dispersal. From the data in Taiwan (1), moving abilities of sterile oriental fruit fly was 200 m to 2.8Km. The information on the movement behavior of this fly is important not only in studying its dispersive ability but also for designing of more precise data on adult fly movement is necessary in the actual control program and the determination of the size of sterile-release or male attraction.

MATERIALS AND METHODS

The stock colonies of the oriental fruit fly have been in the laboratory by artificial method (5). Their F3-F5 generetions were used for experiments. The pupae 1-2 days before emergence were irradiated with 13 Krad from a Cobalt-60 source. After irradiation, the pupae were marked with calco oil blue or uvitex-cfz at 2gm per litre of pupae. The flies emerged within the same day were collected and counted, then reared in the laboratory at 27°C with sugar, protein hydrolysate and water agar (5) for 5 days. The sterile flies were transported to the release area in net cages. Lantern shaped plastic traps, 18 cm in length and 9 cm in diameter, were used for recapturing the marked flies. These traps containing poisoned methyl eugenol (95% methyl eugenol plus 5% DDVP) were hung on trees after the flies were released. Pure acetone was used as an indicator solvent to distinguish the sterile flies from the wild flies.

Centering around the release point, traps were set approximately in four directions (east, west, south, north). Two experiments were conducted from December 1981 to June 1982 including the experiment I area and experiment II area. In the experiment I traps were hung at distances of 150 m, 300 m, 450 m, and 600 m from the release point. The plants were wax apple (host plant) and banana, sugarcane, bamboo and soy bean (not host plant). The map of trial area is shown in Fig. 1. In the experiment II traps were hung at distances of 500 m, 1000 m, 1500 m and 2000 m from the release point in the pineapple field as shown in Fig. 2. Recapture of the flies was made each week in both experiments. The mean dispersive distance (x) was calculated according to the formula (8)

$$x = \frac{\sum_{j=1}^{n} X_j * N_j}{\sum_{j=1}^{n} N_j}$$

where n is the number of traps, Xj is distance between release point and "j" th. trap, and Nj is the number of recaptured flies in the "j" th. trap.

RESULTS AND DISCUSSION

1. The Movement of Sterile Flies

In experiment I the mean distance of each direction are shown in Table 1. The maximum distance of movement is more than 0.6Km (westward direction) and the mean distance of movement is 0.33Km.

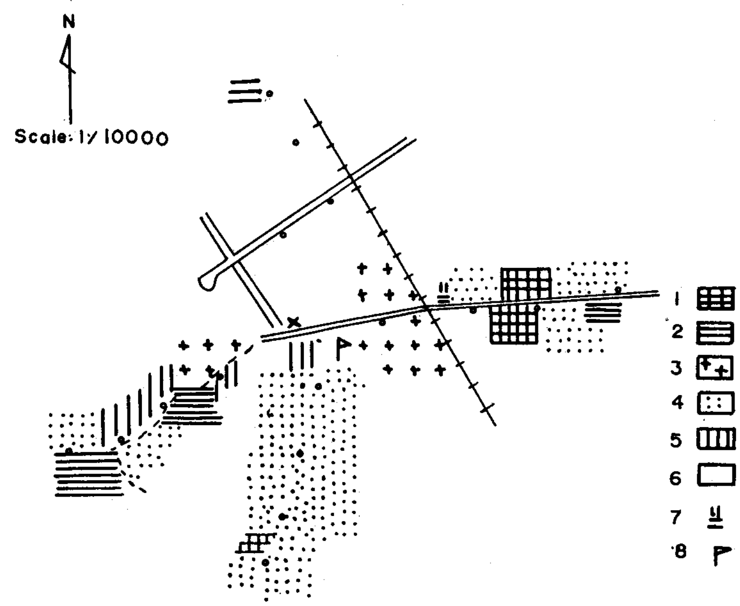

Fig. 1. Map of experiment I area. "X": the release point; Hollow circles: the location traps. (1: Wax apples, 2: Bamboo, 3: Sugarcane, 4: Soybeans, 5: Banana trees, 6: Meadow and building, 7: Pond, 8: School)

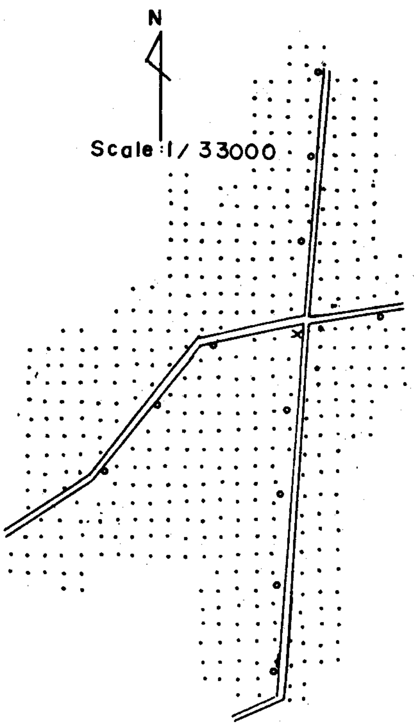

Fig. 2. Map of the experiment II in pineapple field. "X": the release point, Hollow circles: the location of traps.

Table 1. The Distance of Movement of Sterile Flies in the Experiment I Area

Trial No.	Weeks After Release	No. of Flies Released (♀ + ♂)	Mean Distance From Release Point (m)				
			East*	West*	South*	North*	Total*
1		100					
	1		0	0	0	0	0
	2		0	0	0	120	120
	3		0	0	460	0	460
2		3000					
	1		170	170	165	180	185
	2		166	229	134	120	170
	3		181	0	0	0	181
3		3500					
	1		295	416	360	325	360
	2		250	452	100	120	316
	3		257	405	189	195	285
	4		363	288	0	140	270
	5		275	594	418	249	463
	6		0	600	0	300	575
	7		0	600	0	300	583
	8		400	571	0	0	562
	9		280	160	0	210	166
4		3000					
	1		182	177	100	0	246
	2		400	378	0	210	346
	3		0	283	100	190	145
	4		0	160	0	300	225
5		3000					
	1		220	419	165	161	230
	2		150	561	230	266	401
	3		261	521	220	255	391
	4		275	568	260	332	486
	5		309	504	414	298	415
	6		355	381	371	227	335

* Mean distance was calculated according to the formula above. Total means including the mean distance of four directions.

From the above data, the fling of sterile flies was short distance of movement, seems to stay around the host orchards or shelter site. It was belonging to nondispersive movement. Marked *C. capitata* flies released in Hawaii and recovered from 1/4 to 1½ miles from the release point (6), its movement into the fields surrounding the host plant for the purpose of oviposition, food and shelter (2). Adult of *D. dorsalis* in Hawaii were not found in large numbers on fruiting guava trees except during the daily peak of oviposition activity. They move to other plants nearby for food and shelter (3), but in West Pakistan, *D. dorsalis* adults remain in the orchards when there is ripe fruit on the trees, they are not seen on surrounding vegetation, not on the trees of adjacent orchards when there is ripe fruit on the trees, they are not seen on surrounding vegetation, not on the trees of adjacent orchards where there are no fruit (2). From our data, various plants showed attractions to the flies in four directions at different degree, especially in the bamboo field (westward direction). A large number of scales and other honey-dewproducing insects occurred on the bamboo trees; meanwhile, the shelter of bamboo field may provide the good resting site. Similar nondispersive movements have been observed in many of the temperate species of Tephritide, *Rhagoletis cerasi* adults rarely leave an area where host fruit are availabe, even though they are physiologically capable of flights of up to 5 miles per day according to studies with flight mills (4). From the data (table 2), the density of flies including the sterile and wild flies in the bamboo field is the highest. Therefore, adults of *D. dorsalis* show a strong tendency to remain in close association with orchards which contain ripening fruit or sheltering, and their movements within such an orchard are strongly influenced by the presence or absence of food, oviposition, shelter site on the field.

Table 2. The Density of Flies in the Experiment I Area (I: Irradiated Flies; F: Fertile Flies)

Date	Density of Flies in Four Directions (No./Traps)							
	East		West		South		North	
	I	F	I	F	I	F	I	F
1982								
Feb. 18	47	5	13	23	11	0	2	7
Feb. 25	21	8	36	9	1	0	19	3
Mar. 4	5	3	9	19	1	0	4	4
Mar. 9	7	6	13	4	3	0	12	1
Mar. 18	10	2	13	4	0	3	9	9
Mar. 25	2	6	18	80	11	8	7	6
Apr. 7	0	8	5	79	0	3	1	16
Apr. 14	0	4	6	67	0	1	2	2
Apr. 21	12	11	37	101	2	4	0	7
Apr. 30	8	31	7	319	0	15	3	65
May. 7	36	72	41	211	11	61	43	194
May. 13	6	15	39	104	1	9	15	52
May. 20	9	18	25	193	6	11	24	129
May. 27	8	12	125	493	10	10	41	48
June 10	19	49	70	156	124	53	43	173
June 17	63	54	55	43	51	66	44	276
June 24	102	189	74	905	43	395	68	338

In experiment II. the movement of flies in the pineapple field was shown in Table 3. The data show that the maximum distance of movement is more than 2Km (Southward direction) and the mean distance of movement is 0.94Km. In experiment II the distance of movement is greater than the experiment I. this result may be considerd to be due to the movement influenced by the nature of area. In the experiment II, the pineapple (not host plant) was the only plant in the whole area; therefore, the movement in the pineapple field was due to the dispersive action. The distribution of released flies was reported to be mainly influenced by the habitat selection (7). The flight of sterile adults of *D. dorsalis* in the pineapple field showed greater moving distance than those of the host plant orchards above. In the pineapple field, the flies had not food or fruit supply and move considerable distance in a relatively short time, obviously, It was one kind of dispersive movement. Bateman (2) state that at least there appar to be three distinct stimuli which may prompt adults to leave an area and embark on a phase of dispersive activity; the first, is the disappearance of fruit which the population has been utilizing for oviposition, the second is associated with the commencement of warn weather in spring, which initiates movements away from overwintering areas, the third relates to the movements of juvenile adults which after show a strong tendency to disperse during the period between emergence and sexual maturity.

Table 3. The Movement of Dispersal of Sterile-Flies in the Pineapple Field

Trial No.	Weeks After Release	No. of Flies Released (♀ + ♂)	Mean Distance From Release Point (m)				
			East	West	South	North	Total
1		9000					
	1		400	500	625	625	571
	2		400	1292	1250	643	964
	3		400	500	0	500	545
2		5000					
	1		400	500	0	0	411
	2		0	0	1500	0	1500
	3		0	500	833	0	625
3		10000					
	1		400	1020	1227	909	850
	2		400	1375	2000	1300	1145
	3		400	1000	2000	1400	1188
	4		400	1000	1750	1375	1140
	5		400	1221	1450	1000	1108
	6		400	1325	1652	1489	1359

As shown in Table 4, no difference in fly density in four directions was found, indicating that the pineapple field was not a suitable habitat for the fly. Thus, the movement becomes greater when the flies have been released in an area where the pineapple is not a host plant and may be unsuitable for them. This factor should be important in the arrangement of the release point in a sterile-fly release progrom. Furthermore, the fruit flies in the pineapple field may disperse more than 5Km for 2 weeks after releasing (Chiu, unpublished data). The density of both experiments above showed the bamboo field provide the better stimuli, it seems that the bamboo field have a good deal of honey dew and shelter site. Prokopy (11) state that Tephritidae might shelter plants and often observed "rest" on the leaves of density-foliates non-host plants in the vicinity of hosts (3, 11).

2. The Survival Duration of Sterile Flies in the Field:

The maximum survival duration of sterile flies was up to 9 weeks; the mean survival duration was ca. 5 weeks (Table 1), on the other hand, the survival duration of sterile flies was 7 weeks; the mean survival duration was 30 days (Table 3). The maximum survival duration of *D. dorsalis* flies may lasting 55 days after released in the field, sixty percent of the recoveries using methyl eugenol occurred within 16 days after release (12), it is same to our results. It indicated that survival of the released flies in the field was not significantly different between host plants and non host plants area. In this case, adult food and sheltering site must be sufficient for the flies in the field.

Table 4. The Density of Flies in the Pineapple Field (I: Irradiated Flies; F: Fertile Flies)

Date	Density of Flies in Four Directions (No. of Flies/Traps)							
	East		West		South		North	
1982	I	F	I	F	I	F	I	F
Feb. 10	3	0	6	0	4	0	8	0
Feb. 18	5	4	12	3	4	2	7	9
Feb. 24	5	45	2	27	0	14	4	42
Mar. 3	0	0	0	9	0	3	0	1
Mar. 10	0	8	0	10	0	13	0	30
Mar. 17	0	6	0	14	0	5	0	14
Mar. 24	0	7	0	20	0	5	0	10
Apr. 14	0	6	0	13	0	5	0	3
Apr. 21	8	1	1	3	0	3	0	1
Apr. 28	0	7	0	19	1	11	0	15
May. 5	23	39	30	12	14	22	33	20
May. 12	8	10	8	7	3	14	10	29
May. 20	3	5	3	4	1	3	10	85
May. 27	20	11	5	16	18	40	25	85
June 10	31	38	53	44	50	149	10	56
June 17	13	257	4	174	33	367	45	718

3. The Recapture Rate of Released Flies:

The recapture rate is variable which was found to be 2.20-10.76-30.36 (Table 5) and 0.27-1.79-4.45 (Table 6). Moreover, the recapture rate of released melon flies in Okinawa was 4.35-7.40-12.42 (7). Obviously, the recapture rate of sterile flies was same to our data. It can be seen the recapture rate of flies was very low. Therefore, the recapture date is influenced by the host plant, and the distribution pattern of released flies is in accordance with the habitat selection.

Table 5. The Recapture Rate of Released Flies in Experiment I Area

Trial No.	Weeks After Release	No. of Flies Released (♀ + ♂)	Recapture Rate of Released Flies (%)				
			East	West	South	North	Total*
1		100					
	1		0	0	7	0	7
	2		0	0	0	1	1
	3		0	1	0	0	1
		sum	0	1	7	1	9
2		3000					
	1		0.4	0.6	0.06	0.46	1.52
	2		1.29	0.37	0.31	0.05	2.01
	3		0.23	1.02	0.03	0.54	1.82
		sum	1.92	1.99	0.40	1.05	5.36
3		3500					
	1		0.37	1.02	0.03	0.54	1.96
	2		0.14	0.26	0.03	0.11	0.54
	3		0.29	0.37	0	0.26	0.92
	4		0.06	0.51	0.31	0.20	0.08

	5			0.20	0.37	0.09	0.34	1.00
	6			0	0.14	0	0.03	0.17
	7			0	0.20	0	0.07	0.27
	8			0.03	0.63	0	0	0.66
	9			0.20	0.07	0	0.03	0.30
			sum	1.29	3.57	0.46	1.58	6.90
4		3000						
	1			0.37	0.60	0.07	0	1.04
	2			0.07	0.17	0	0.07	0.31
	3			0	0.30	0.23	0.26	0.79
	4			0	0.03	0	0.03	0.06
			sum	0.44	1.10	0.30	0.36	2.20
5		3000						
	1			1.20	1.00	0.13	1.17	3.50
	2			0.20	1.27	0.03	0.47	1.97
	3			0.30	0.83	0.20	0.80	2.13
	4			0.27	4.17	0.33	1.37	6.14
	5			0.63	2.33	4.13	1.43	8.52
	6			2.10	1.83	1.70	1.47	7.10
			sum	4.70	11.43	6.52	6.71	30.36

* Total means including four directions.

Table 6. The Recapture Rate of Released Flies in Pineapple Field

Taial No.	Weeks After Release	No. of Flies Released (♀ + ♂)		Recapture Rate of Released Flies (%)				
				East	West	South	North	Total*
1		9000						
	1			0.03	0.07	0.04	0.09	0.23
	2			0.06	0.13	0.04	0.08	0.31
	3			0.06	0.02	0	0.04	0.12
			sum	0.15	0.22	0.08	0.21	0.66
2		5000						
	1			0.16	0.02	0	0	0.18
	2			0	0	0.03	0	0.03
	3			0	0.05	0.01	0	0.06
			sum	0.16	0.07	0.04	0	0.27
3		10000						
	1			0.23	0.25	0.11	0.33	0.92
	2			0.08	0.08	0.03	0.10	0.29
	3			0.03	0.03	0.01	0.10	0.17
	4			0.20	0.05	0.18	0.20	0.63
	5			0	0.05	0	0	0.05
	6			0.31	0.53	0.50	0.10	1.44
	7			0.13	0.04	0.33	0.45	0.95
			sum	0.98	1.03	1.16	1.28	4.45

* Total means including four directions.

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東方果實蠅在田間之移動現象

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東方果實蠅之移動受田間之作物相及生育期影響很大，尤以開花及果實成熟期爲甚，在寄主及非寄主果園之移動現象差異很大；在鳳梨園（非寄主）其飛行距離超過2公里以上，平均爲0.94公里，在蓮霧園（寄主）其飛行距離最遠僅0.60公里，平均爲0.33公里。另試驗中釋放之不孕性成蟲在田間平均存活五週之久，更長者可存活9週。成蟲在田間之移動距離有時很明顯地可看出越飛越遠，但有時却數週仍停留在原處或某一點徘徊，發生徘徊之場所，多爲較隱密且通風不良之樹叢，尤以寄主果園及濃密之竹園，可提供其取食，產卵及停息之場所，發生之蟲數最高。