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Attracting Effectiveness of Fruit Net-bags and Victor Fly Traps for the Oriental Fruit Fly, *Bactrocera dorsalis* (Diptera: Tephritidae), at a Touliu Guava Orchard 【Research report】

果實網袋包與渦旋式誘蠅器在斗六番石榴園對東方果實蠅 (*Bactrocera dorsalis*) (雙翅目：果實蠅科) 之誘殺效果【研究報告】

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Abstract

The degree of fruit infested by the Oriental fruit fly, *Bactrocera dorsalis* (Hendel), decreased when using a guava-sticky-bag (fruit net-bag) and methyl-eugenol Victor fly trap but not when only using a Victor fly trap in a guava orchard. However, adding a McPhail trap which contains poisoned protein hydrolysate to the guava-sticky-bag and Victor fly trap treatment did not significantly increase the effectiveness for overall fly attractiveness. However, when the fly population increased, adding the action of cleaning the orchard decreased the degree of damaged fruit. According to a series of decreasing trapped fly numbers and high control rate in a later stage in guava-sticky-bag treated orchards, this also showed good trapping efficiency. Testing data showed that only the Victor fly trap treatment could catch a large number of male flies, but it did not decrease the degree of damaged fruit. In addition, using the guava-sticky-bag and periodically cleaning the orchard also decreased the ratio of gravid female flies; however, the ratio increased again when the fly source of the intruder dramatically increased.

摘要

在番石榴園同時懸掛成熟番石榴果實網袋包與內置含甲基丁香油之渦旋式誘蠅器，果實被害度會比只懸掛渦旋式誘蠅器為低，如再增加懸掛裝有含毒蛋白水解物誘餌之麥氏誘蟲器時，並未能顯著提高對東方果實蠅 *Bactrocera dorsalis* (Hendel) 之誘殺效果。由各懸掛番石榴網袋包試區誘殺雌、雄蟲數之持續下降及後期防治率之逐漸提高，證實其確有不錯之誘殺效果。另由試驗得悉，只懸掛渦旋式誘蠅器之試區，雖亦能誘到大量之雄蟲，但在短期內卻無法降低果實之被害度，其因乃部份雌蟲會在懸掛渦旋式誘蠅器試區之成熟果實上活動。另外，果園中曾發現懸掛果實網袋包與定期清園亦能降低東方果實蠅懷卵之雌蟲比率，然而當由外飛入蟲源增多時則懷卵之雌蟲比率又會升高。

Key words: *Bactrocera dorsalis*, fruit net-bag, Victor fly trap, attracting effectiveness

關鍵詞: 東方果實蠅、果實網袋包、渦旋式誘蠅器、誘殺效果

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果實網袋包與渦旋式誘蠅器在斗六番石榴園對東方果實蠅 (*Bactrocera dorsalis*) (雙翅目：果實蠅科) 之誘殺效果

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摘 要

在番石榴園同時懸掛成熟番石榴果實網袋包與內置含甲基丁香油之渦旋式誘蠅器，果實被害度會比只懸掛渦旋式誘蠅器為低，如再增加懸掛裝有含毒蛋白水解物誘餌之麥氏誘蟲器時，並未能顯著提高對東方果實蠅 *Bactrocera dorsalis* (Hendel) 之誘殺效果。由各懸掛番石榴網袋包試區誘殺雌、雄蟲數之持續下降及後期防治率之逐漸提高，證實其確有不錯之誘殺效果。另由試驗得悉，只懸掛渦旋式誘蠅器之試區，雖亦能誘到大量之雄蟲，但在短期內卻無法降低果實之被害度，其因乃部份雌蟲會在懸掛渦旋式誘蠅器試區之成熟果實上活動。另外，果園中曾發現懸掛果實網袋包與定期清園亦能降低東方果實蠅懷卵之雌蟲比率，然而當由外飛入蟲源增多時則懷卵之雌蟲比率又會升高。

關鍵詞：東方果實蠅、果實網袋包、渦旋式誘蠅器、誘殺效果

前 言

東方果實蠅 (*Bactrocera dorsalis* (Hendel)) 為台灣經濟果樹的主要害蟲，施用含毒甲基丁香油誘殺板為目前防治策略之主軸 (Liu, 1991; Chen *et al.*, 2001)。此種滅雄法經室內測試 (Chu *et al.*, 1985) 及實際在田間應用結果 (Chiu and Chu, 1988; Ho *et al.*, 2001b)，證實有甚佳誘殺效果。然因受限於台灣山坡地果園複雜環境 (Huang, 1997)、人文背景及有限之防治資材，往往無法達到全面性、長期性的理想效果。國內外專家學者為因

應全面、長期滅雄之困難度，亦著手食物誘餌之開發研究 (Chen, 1990; Liu *et al.*, 1996)，並採用各種有效之誘引資材及防治配套措施 (Prokopy and Economopoulos, 1975; Gazit *et al.*, 1998; Chen *et al.*, 2001)，企圖在短時段之結果期間能於局部地區之果園內，作到有效的誘殺雌、雄蟲以降低果實被害率之防治目的。經何氏等 (Ho *et al.*, 2001a, 2003a, b, c; Ho, 2003) 測試結果，採用果實網袋包配合渦旋式誘蠅器，確實能有效的誘殺果園內的雌、雄蟲而降低果實之被害。果實網袋包乃是採用番石榴、香蕉、芒果或香瓜等香甜多汁之成熟

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果實，置於紗網袋內，其外再覆上黃色粘紙，藉果餌之天然氣味有效誘殺前往取食之雌、雄蟲。渦旋式誘蠅器是一種入口旋渦式及暗室原理設計之誘捕器，其內可採用甲基丁香油誘殺板，能發揮較長期有效之誘殺能力。果園利用果實網袋包搭配渦旋式誘蠅器，能綜合食物誘餌、黃色粘紙、清理落果及甲基丁香油等誘殺雌、雄之較大優點，使整體東方果實蠅之防治工作較易達到經濟、有效又安全、易行之效益。本試驗係在番石榴果園中採用此兩種資材防治東方果實蠅，借由各試區之果實被害度、誘殺蟲數及防治率等進行分析比較，並探討園區目測蟲源及懷卵雌蟲族群之變化情形。

材料與方法

一、果實被害度調查

於 2000 年 12 月至 2001 年 2 月間，在雲林縣斗六市番石榴園（第一期果）首先進行試驗。試驗分四試區，即 A 番石榴果實網袋包（每包含中山種成熟果實約 200 g，外套高冠牌 22×22 cm 粘紙板）加渦旋式誘蠅器（台灣嘉義民雄瑞芳公司出品之安啦[®] Victor fly trap，內含 4.5×4.5×0.9 cm 甲基丁香油誘殺板），B 除懸掛上述二者另增掛麥氏誘蟲器，內含含毒蛋白水解物（稀釋 20 倍，並加入 50% 之馬拉松粉劑 200 倍），C 除前兩者外，另增加每週清除果園之被害落果之處理，對照區（CK）只懸掛渦旋式誘蠅器。各處理之誘殺器懸掛係在各試區之前、後端各懸掛一個渦旋式誘蠅器；A、B 及 C 區則每間隔 2 株果樹懸掛一組網袋包；B 區則每隔 2 株果樹另加掛一組麥氏誘蟲器。各試區約 1 分地，各種植中山種番石榴 68 株，分成 4 列，共各懸掛 10 組誘殺器。A、B、C 區與 CK 區相距約 2 公里，與其他果園隔離。調查方法係每週均勻摘取各試區中

央植株上近成熟之果實，共計 6 包樣品，每包 20 粒。攜回室內計算被害果數，及記錄果實之被產卵孔數。後於 3~4 月間於原試區（第二期果）繼續進行第二次試驗，其中因蛋白質水解物誘餌效果不佳故不再加掛麥氏誘蟲器，即將原來 A、B、C 三區之 A 區保留，B 區去除，C 區改稱為 B 區，而其他試驗設計及調查方法皆相同。

將上述調查果實之被產卵孔數依序分成 1、2、3、4、5 及 6 孔以上等 1~6 個等級（亦即 1 孔為 1 級，2 孔為 2 級…5 孔為 5 級，6 孔以上為 6 級），並依下列公式求算各處理試區每週之平均被害度：

$$\text{被害度}(\%) = \frac{\sum (\text{等級} \times \text{該等級被害果數})}{6 \times \text{調查果數}} \times 100$$

二、誘殺蟲數與防治率

在上述試區於第一期果調查 10 個果實網袋包、10 個麥氏誘蟲器及 2 個渦旋式誘蠅器之雌、雄成蟲誘殺數。第二期果則因試區調整擴大而改為懸掛 16 個網袋包及 3 個渦旋式誘蠅器，不再加掛麥氏器，而 CK 區則仍維持 2 個渦旋式誘蠅器。將第 1 週之誘殺雄蟲數視為處理前期之蟲數，第 2 週以後之誘殺雄蟲數則分別視為處理後期之蟲數。再依下列公式求算各處理試區之每週平均防治率：

$$\text{防治率}(\%) = \left(1 - \frac{\text{處理組處理後之雄蟲數} \times \text{對照組處理前之雄蟲數}}{\text{處理組處理前之雄蟲數} \times \text{對照組處理後之雄蟲數}}\right) \times 100$$

三、可能懷卵雌蟲比率之調查

在第二期果試驗調查時，觀察 A、B 兩試區中央部位 4 組粘紙板上之活雌蟲（亦即剛誘到的），將其區分為腹部較飽滿堅實者列入可

表一 番石榴試區受東方果實蠅為害果實之被害度(2000-2001)

Table 1. Degree of fruit infested by Oriental fruit flies in a guava orchard (2000~2001)

Duration (Dec. 2000~ Feb. 2001)	Degree of fruit infested (%) ¹⁾ with different treatments			
	Guava-sticky-bag (GSB) + Victor fly trap (VFT)	GSB + VFT + Protein hydrolysate	GSB + VFT + Clean orchard	Victor fly trap
Week 0	96.3	95.3	91.7	92.9
Week 1	93.1	73.6	84.3	92.3
Week 2	49.6	59.9	67.8	98.5
Week 3	24.6	31.4	46.5	93.1
Week 4	16.4	17.4	23.5	99.2
Week 5	22.8	28.9	33.5	100
Week 6	46.7	47.4	37.4	98.8
Week 7	50.3	27.2	27.9	92.2
Week 8	44.3	12.5	14.2	100
Avg. ²⁾	49.3 ^b	43.7 ^b	47.4 ^b	96.3 ^a

¹⁾ The degree of fruit infested was calculated by the formula shown in "Material and Methods".

²⁾ Means in a line followed by the same letter do not significantly differ ($p = 0.05$, DMRT).

能懷卵雌蟲與腹部較虛空柔弱者列入羽化不久之未懷卵雌蟲。因其為剛捉到之新鮮成蟲，可由外型作正確之判斷懷卵與否（少數不能確定者則不予列入計算）。共重複調查四次，並計算每次懷卵雌蟲之百分率。

四、統計分析

將上述各試區各項目調查之誘殺蟲數先行開方處理，而求得之百分率則經反正弦(Sin^{-1})轉角換算後，再以鄧肯氏多變域測驗分析，比較各處理間 95% 程度之差異顯著性($p = 0.05$, DMRT)。

結 果

一、果實被害度

將被產卵為害之等級所求得之被害度列於表一及表二中。於第一期果（表一）調查結果，於有懸掛果實網袋包之三區中，以加掛蛋白水解物誘餌試區之被害度最低，但統計上彼此尚未達顯著水準，唯此三個試區皆顯著較只懸掛渦旋式誘蠅器試區為低。在只懸掛網袋包

之試區被害度自第 2 週後急速下降，但至第 6 週時又有回昇之情形。於第 8 週時，在加掛蛋白水解物毒餌區被害度降至 12.5%；有清除落果之試區則降至 14.2%，而未懸掛網袋包對照區則仍維持很高之被害度。第二期果（表二）有懸掛網袋包之處理區亦有相同之趨勢，被害度持續降，至第 5 週時才又回昇，而未懸掛網袋包之對照區則一直維持很高（平均 97.1%）之被害度。

二、誘殺蟲數與防治率

各試區之誘殺蟲數及防治率分別如表三、表四。由表三顯示在有懸掛網袋包及渦旋式誘蠅器之三試區中，所誘殺之雌蟲平均數約略相等，其中蛋白水解物之誘殺量僅占該試區之 15.3%，並未能增加全體之誘雌量。同此，三試區之誘雄量亦約略相等，而蛋白水解物之誘殺量僅占該區之 16.3%。各試區懸掛之渦旋式誘蠅器誘殺雄蟲量亦無顯著差異，僅在未懸掛網袋包之對照區的後期誘雄量有呈現增多之情形。另在三懸掛誘餌試區之平均防治率，亦未有顯著差異。在第二期果（表四）兩組網

表二 番石榴試區受東方果實蠅為害果實之被害度(2001)

Table 2. Degree of fruit infested by Oriental fruit flies in a guava orchard (2001)

Duration (Mar.~Apr. 2001)	Degree of fruit infested (%) ¹⁾ with different treatments		
	Guava-sticky-bag (GSB) + Victor fly trap (VFT)	GSB + VFT + Clean orchard	Victor fly trap
Week 0	27.4	14.6	90.9
Week 1	18.5	11.1	92.07
Week 2	12.5	8.7	100
Week 3	8.6	5.7	100
Week 4	26.4	13.5	99.9
Week 5	41.1	17.8	100
Avg. ²⁾	22.4 ^b	11.9 ^b	97.1 ^a

¹⁾ The degree of fruit infested was calculated by the formula shown in "Material and Methods".

²⁾ Means in a line followed by the same letter do not significantly differ ($p = 0.05$, DMRT).

表三 番石榴試區誘殺東方果實蠅數及防治率(2000-2001)

Table 3. Trapped number and control rate for the Oriental fruit fly in a guava orchard (2000~2001)

Duration (Dec. 2000 ~Feb. 2001)	No. of females/trap			No. of males/trap						Control rate ¹⁾					
	T ²⁾ A Bag ³⁾	TB Bag	TC PH ⁴⁾ Bag	TA Bag	ME ⁵⁾	TB Bag	PH	ME	TC Bag	ME	CK ME	TA (%)	TB (%)	TC (%)	
Week 1	79.2	67.2	6.1	94.0	74.3	101	56.6	3.3	104	55.0	143	102	--	--	--
Week 2	79.3	93.4	15.9	97.3	76.7	46.5	70.2	15.0	66.4	74.1	53.0	104	10.7	0	0.6
Week 3	70.5	57.5	12.9	109	70.0	21.5	52.6	6.3	38.0	116	36.5	30.5	0	0	0
Week 4	135	89.6	31.2	95.2	135	103	77.1	33.4	115	85.9	82.0	92.0	0	0	0
Week 5	78.6	60.3	7.2	47.3	85.5	28.0	47.1	6.8	78.5	35.5	42.0	17.5	0	0	0
Week 6	41.0	31.9	2.4	18.5	44.3	24.5	26.7	2.8	25.5	14.1	11.5	26.5	0	0	24.5
Week 7	21.2	17.8	1.5	11.8	18.7	18.0	18.6	1.3	10.0	8.3	3.5	32.5	25.9	14.8	66.2
Week 8	12.7	10.7	0.6	6.5	10.0	14.0	8.6	0.3	5.0	4.5	11.5	63.5	78.2	80.3	86.9
Avg. ⁶⁾	64.7 ^a	53.6 ^a	9.7 ^b	60.0 ^a	64.3 ^A	33.0 ^A	44.7 ^A	8.7 ^B	55.3 ^A	49.2 ^A	47.9 ^A	58.3 ^A	16.4 ^a	13.6 ^a	25.5 ^a

¹⁾ The control rate was calculated by the formula shown in "Material and Methods".

²⁾ Treatment: A. guava-sticky-bag + Victor fly trap,

B. guava-sticky-bag + Victor fly trap + protein hydrolysate,

C. guava-sticky-bag + Victor fly trap + clean orchard, and

CK. with Victor fly trap only.

³⁾ Bag: guava-sticky-bag.

⁴⁾ PH: poisonous protein hydrolysate.

⁵⁾ ME: methyl-eugenol in Victor fly trap.

⁶⁾ Means in the same comparison group (TA-CK) followed by the same letter do not significantly differ ($p = 0.05$, DMRT).

袋包試區之誘殺雌、雄數亦無顯著差異，其中由網袋包所誘殺之雄蟲數亦與該區渦旋式誘蠅器誘殺者無差異，但與只懸掛渦旋式誘蠅器誘殺之對照區卻有顯著差異。此時期兩試區懸

掛網袋包之防治率平均各約為 70%，並無顯著差異。

三、可能懷卵雌蟲之比率調查

表四 番石榴試區誘殺東方果實蠅數及防治率(2001)

Table 4. Trapped number and control rate for the Oriental fruit fly in a guava orchard (2001)

Duration (Mar.-Apr. 2001)	No. of females/trap		No. of males/trap					Control rate	
	T ¹ A Bag	TB Bag	TA		TB		CK ME	TA (%)	TB (%)
			Bag	ME	Bag	ME			
Week 1	29.9	33.0	10.1	77.0	14.9	66.7	409	--	--
Week 2	8.9	11.4	3.2	11.3	6.8	5.7	303	82.8	61.2
Week 3	17.1	20.7	5.5	29.0	9.6	16.3	664	72.6	71.3
Week 4	29.7	26.8	18.3	19.3	19.1	6.0	1068	65.8	71.7
Week 5	26.4	22.6	17.6	52.0	13.1	24.7	1053	56.7	74.8
Avg.	22.4 ^a	22.9 ^a	10.9 ^B	37.7 ^B	12.7 ^B	23.9 ^B	699 ^A	69.5 ^a	69.8 ^a

¹⁾ Treatment: A. guava-sticky-bag + Victor fly trap.

B. guava-sticky-bag + Victor fly trap + clean orchard.

(The other notes are the same as in Table 3.)

表五 番石榴園試區東方果實蠅之懷卵雌蟲數及比率

Table 5. Number and ratio of gravid females of Oriental fruit fly in a guava orchard

Duration (Mar.-Apr. 2001)	Guava-sticky-bag + Victor fly trap			GSB +VFT + Clean orchard		
	No. of females		Ratio % (eggs/total)	No. of females		Ratio % (eggs/total)
	With eggs	Without eggs		With eggs	Without eggs	
Week 0	2.3	1.8	56.1	3.3	1.8	64.7
Week 2	0.3	0.5	37.5	0.5	2.3	17.9
Week 4	3.8	1.0	79.2	1.0	1.0	50.0
Week 6	2.3	1.0	69.7	2.8	1.3	68.3
Avg. ^{NS}	2.2	1.1	66.7	1.9	1.6	54.3

^{NS}: Not significantly different.

在懸掛網袋包二試區中所誘到可能懷卵雌蟲數，將其平均與標準偏差及比率等列於表五中。由其平均顯示在不清園區之可能懷卵雌蟲數為無懷卵者之兩倍，而在清園區則僅為1.2倍，唯兩者未達顯著差異水準。整體而言，兩試區之可能懷卵雌蟲之比率，均有在第2週時下降，至第4週時又昇高之現象。

討 論

於表一中在第5、6週時，只懸掛網袋包與渦旋式誘蠅器之試區果實被害度有回昇之現象，而於加掛蛋白水解物毒餌及有清園之處

理區，第7、8週之被害度又再度下降，顯示蛋白水解物誘餌及清園確有發揮某些程度的防治效果。第二期果（表二）之結果，因期間已間隔三週未再懸掛果實包，可能受前期懸掛之累積效果影響，兩試區於開始懸掛時之被害度皆已顯著較未懸掛區為低。在第二期果之試驗後期，因有外面湧入的大量懷卵雌蟲源（表五），使得懸掛網袋包及有清園之試區的果實被害度昇高，唯在清園區尚能維持較低之被害度。然而第二期果後期的未懸掛網袋包之對照區，被害度則幾達100%。

在表三中，利用網袋包處理之三個試區誘殺雌、雄蟲數持續下降，顯示出整體網袋包俱

有不錯之誘殺效果，此與 Ho *et al.* (2001a) 之試驗結果相似，另由此三區後期之防治率之昇高亦能明確的證實其效果。第一期果在三懸掛試區之誘蟲數與未懸掛對照區並無顯著差異，顯示此時期氣溫低、族群密度低、活動遷移力弱，故在比較隔離、獨立之果園中，外侵之蟲源並不多。另外此三區之防治率亦無顯著差異，顯示增用蛋白水解物或清理果園，在未外侵蟲源時，並沒有明顯增加網袋包之效果。由第二期果（表四）後期之調查結果，在未懸掛網袋包之對照區誘得大量之雄蟲，顯示此時期已有大量蟲源存在。此時在未清園區之防治率亦稍呈下降，而有清園之試區防治率則仍維持 70% 以上，亦即此時之清園措施（減少誘引源）較能有效增加網袋包之防治效果。綜由一、二期果在有懸掛網袋包試區累積之防治率，亦能看出利用番石榴網袋包誘殺果實蠅確實能提高防治效果。

在第二期果開始作懷卵雌蟲調查時，因已間隔三週未懸掛網袋包誘殺，故懷卵之雌蟲比率較高。懸掛網袋包後在有清園試區第 2 週之懷卵比率偏低（僅為無懷卵者之 21.7%），可能是因清園後多餘競爭之誘引源減少而致使誘入之懷卵雌蟲（進入園內準備產卵）之數量減少。然至試驗後期由於果實大多已採收，故在不清園區之落果亦相對減少，另又由於該時期外侵之蟲源大量增多，致使清園與不清園試區之懷卵雌蟲比率又同時回昇。

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Attracting Effectiveness of Fruit Net-bags and Victor Fly Traps for the Oriental Fruit Fly, *Bactrocera dorsalis* (Diptera: Tephritidae), at a Touliu Guava Orchard

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ABSTRACT

The degree of fruit infested by the Oriental fruit fly, *Bactrocera dorsalis* (Hendel), decreased when using a guava-sticky-bag (fruit net-bag) and methyl-eugenol Victor fly trap but not when only using a Victor fly trap in a guava orchard. However, adding a McPhail trap which contains poisoned protein hydrolysate to the guava-sticky-bag and Victor fly trap treatment did not significantly increase the effectiveness for overall fly attractiveness. However, when the fly population increased, adding the action of cleaning the orchard decreased the degree of damaged fruit. According to a series of decreasing trapped fly numbers and high control rate in a later stage in guava-sticky-bag treated orchards, this also showed good trapping efficiency. Testing data showed that only the Victor fly trap treatment could catch a large number of male flies, but it did not decrease the degree of damaged fruit. In addition, using the guava-sticky-bag and periodically cleaning the orchard also decreased the ratio of gravid female flies; however, the ratio increased again when the fly source of the intruder dramatically increased.

Key words: *Bactrocera dorsalis*, fruit net-bag, Victor fly trap, attracting effectiveness