

柑桔粉介殼蟲 (*Planococcus citri* (Risso))

性費洛蒙之生物檢定法

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摘 要

以培養皿、飛行室及圓形轉盤等方法，進行檢定不同日齡、或蟲數柑桔粉介殼蟲雌性成蟲及與不同顏色黏膠板組成之誘捕器對雌性成蟲誘引之試驗，結果顯示圓形檢定裝置為測試柑桔粉介殼蟲性費洛蒙最可行之方法。所得結果顯示以40隻以內18日齡雌性成蟲為誘引源時，對雌性成蟲極具誘引效果，此種標準化的處女雌蟲，可嘗試應用於該粉介殼蟲族群發生、消長之偵測。另外紅顏色之黏膠板誘捕器對雌性成蟲誘捕效率較高，可為未來設計該粉介殼蟲性費洛蒙誘捕器時之參考。柑桔粉介殼蟲雄性成蟲之飛行及其對雌性費洛蒙之反應行為，顯著地受光照的影響，雄蟲在黑暗間皆靜止不活動，但於開燈後30分鐘以內，雄蟲被誘捕數最多，其後隨曝光時間增加，雄蟲被誘捕數有顯著降低的趨勢；至開燈2小時後，雄蟲幾不飛翔且不對雌蟲反應，故檢定該粉介殼蟲性費洛蒙誘蟲活性時，宜於開燈後2小時內進行。生物檢定顯示以冰醋酸或無水酒精浸泡柑桔粉介殼蟲雌性成蟲之粗萃取液，最具誘蟲活性，提供未來性費洛蒙組成份鑑定之材料。

(關鍵字：柑桔粉介殼蟲、粗萃取液、培養皿法、飛行室法、圓形轉盤法、紅色誘捕器、日周律。)

ABSTRACT

Hwang, Jenn-Sheng and Yau-I Chu. (1987) A Bioassay Method of the Sex Pheromone of the Citrus Mealybug, *Planococcus citri* (Risso). Plant Prot. Bull. (Taiwan, R.O.C.) 29:307—319 (Pesticide Formulation, Taiwan Agricultural Chemicals and Toxic Substances Research Institute, Taichung, Taiwan 41301, R.O.C. and Department of Pathology and Entomology, National Taiwan University, Taipei, 10764, R.O.C.)

The attractiveness of the female sex pheromone of the citrus mealybug, *Planococcus citri* (Risso), to male adults was evaluated with the following three methods: petri-dish, free-flight room, and turn-table olfactometer method. The results showed that the last method appeared to be the most advisable one. It also showed that a number of forty 6- to 18-day-old virgin females is enough to provide as a pheromone source. The preference of the male to various colored sticky-board with virgin females was studied. Among 5 tested colors, the red one was the most attractive color. The photoperiodism is considered to be an additional unnegligible factor that will influence the effectiveness of the bioassay. During the scotophase, scarce male flew and was attracted by the pheromone trap while an obvious peak of response appeared within 30 min after the lighting. Male activity was ceased 2 hours after the exposure to light. The crude solution extracted from virgin females with glacial acetic acid or absolute ethanol was the most attractive to the male of the citrus mealybug.

(Key words: *Planococcus citri*, extracted solution of virgin females, petri-dish, free-flight room, turn-table olfactometer, red sticky-board, photoperiodism.)

緒 言

柑桔粉介殼蟲 (*Planococcus citri* (Risso)) 爲分佈全球的重要害蟲之一，目前係本省番石榴及其他多種經濟果樹的關鍵害蟲，因其體型細小、外被粉狀或綿狀臘質物，並喜群棲於寄主縫隙之習性，故不易偵測粉介殼蟲早期的發生爲害，進而決定防治適期，致使一般施藥難達徹底防治效果^(1,2)。近年昆蟲性費洛蒙的研究，曾發現並鑑定出屬盾介殼蟲科 (Diaspididae) 的四種硬介殼蟲及屬粉介殼蟲科 (Pseudococcidae) 的二種粉介殼蟲之雌性費洛蒙組成份，其中包括柑桔粉介殼蟲性費洛蒙主成份爲 (+)-2,2-二甲基-3 (異丙烯基)-1-環丁烷甲基乙酯⁽¹⁵⁾；而多位學者專家並曾以處女雌蟲或人工合成性費洛蒙劑與黏膠板組成誘捕器，於果園進行介殼蟲類的調查偵測試驗，咸認爲介殼蟲類的性費洛蒙偵測裝置，是一可替代傳統人工調查偵測害蟲發生的工具及方法，並可因此改進防治適期，降低殺蟲劑的過量使用^(4,8,9,11,13,14)。

因此，本研究之目的欲以柑桔粉介殼蟲爲材料，建立簡易性，靈敏度高及再現性大的標準化粉介殼蟲性費洛蒙生物檢定技術，並初步

試驗粉介殼蟲性費洛蒙萃取之方法，期能於未來配合化學人員之性費洛蒙組成份鑑定及合成工作，並作爲將來建立該蟲性費洛蒙誘捕偵測系統時之基礎參考資料。

材 料 與 方 法

一、供試昆蟲

試驗之柑桔粉介殼蟲係採自彰化縣社頭鄉番石榴園，於 $25 \pm 1^\circ\text{C}$ ， $70 \pm 5\%$ RH，及 12 小時光照 (313 ± 166 lux) 之養蟲室內，以南瓜爲寄主大量繁殖該蟲，供作試驗蟲源。雄性成蟲分離方法依 Negishi *et al.*⁽¹⁰⁾ 方式進行，可簡易有效地自南瓜表面獲取雄蟲。雌性成蟲之分離則於末齡若蟲脫皮爲成蟲時，立即以細毛筆挑置於含新鮮番石榴葉片之培養皿內。

二、柑桔粉介殼蟲處女雌蟲性費洛蒙誘引源及誘捕器之製備

柑桔粉介殼蟲雌蟲性費洛蒙誘引源之製備，係將欲測試之雌性成蟲，以細毛筆挑置於內含番石榴葉之不銹鋼製的小網罩內 (直徑 3.5 公分，高 1.0 公分)，網罩底部以石臘膜 (Parafilm) 包封，周圍則以 2 公分寬之双面膠帶環繞，頂部爲 0.21 mm 細目的鋼網，使雌成蟲所分泌之性費洛蒙可自小網罩內散發出來

，受到誘引之雄成蟲可被膠帶黏著。或將前述雌蟲誘引源裝置於黏膠紙板 (10×10公分) 中央，以組成該粉介殼蟲性費洛蒙誘捕器。

三、柑桔粉介殼蟲性費洛蒙之生物檢定法

(1) 培養皿檢定法 (Petri-dish method)

為測試不同日齡柑桔粉介殼蟲雌成蟲對雄成蟲之誘引性，取最後一次脫皮經 2~7 天，或 0、3、6、9、12、15 天之六種不同日齡雌性成蟲各 40 隻，依上述二之方法製備成六種不同日齡雌蟲之性費洛蒙誘捕器。先將此等誘引源分置於大型培養皿 (直徑 22 公分，高 7 公分，周圍具六個 0.6 公分通氣孔) 內之六個等距角落，培養皿中央則放置一個收容 100 隻 2~3 日齡雄成蟲之小皿 (直徑 3.5 公分，高 1 公分)，再以保鮮膜覆蓋大培養皿口，並將此培養皿檢定裝置，每日於下午四時，置於 $25 \pm 1^\circ\text{C}$ ，6~18 時為光照期 ($178 \pm 6.5 \text{ lux}$) 之定溫箱內，於隔夜翌晨照光 4 小時後，記錄被不同日齡雌蟲誘捕之雄蟲數。結果之統計分析，係將各處理誘捕雄蟲數化為百分率，再經 $\arcsin \sqrt{x}$ 數值轉換後，以鄧肯氏多變異分析法檢定各處理間差異之顯著性。

不同蟲數 (0~160 隻) 的六日齡柑桔粉介殼蟲雌成蟲對雄成蟲誘引性之測試，亦以相同方法進行檢定，惟經四日連續觀察記錄雄蟲被誘捕情形，再統計分析結果。

(2) 飛行室檢定法 (Free-flight room method)

所用飛行室為 $3.6 \times 4.2 \times 3.0$ 公尺，並維持 $25 \pm 2^\circ\text{C}$ ， $70 \pm 10\%$ RH 及 6~18 時為光照期 ($159 \pm 3.9 \text{ lux}$) 之條件。測試不同日齡 (0~15 日) 柑桔粉介殼蟲雌成蟲對雄成蟲之誘引性，係於飛行室中央地面劃一直徑為 120 公分之圓周，在圓周上等距離擺置六個圓筒玻璃 (直徑 10 公分，高 30 公分)；再將備妥各含有 40 隻六種日齡之雌成蟲為誘引源，與黏膠紙板 (10×10公分) 組成性費洛蒙誘捕器，並逢機平置於圓筒玻璃上；另於圓心位置擺置一內含約 500~600 隻 2~3 日齡雄成蟲之培養皿。每次試驗於下午四時設置，經隔夜翌晨照光 4 小時後，檢視培養皿內殘存雄蟲數，及不同誘引源黏膠板上誘捕之雌蟲數。統計分析方

法如三 (1) 者。

不同蟲數 (0~160 隻) 的六日齡柑桔粉介殼蟲雌成蟲對雄成蟲誘引性之測試，亦以上法進行檢定試驗及分析結果。

測試雄成蟲對不同顏色黏膠板之反應能力，則以 40 隻六日齡雌成蟲為誘引源，與上塗黏膠之紅、黃、綠、藍、白、黑等不同顏色之黏膠板 (10×10公分)，組成性費洛蒙誘捕器，再如上法進行檢定試驗及分析結果。

(3) 圓形轉盤檢定法 (Turn-table olfactometer method)

為消除飛行室檢定法中可能發生的誘引源方位效應 (Position effects)，乃參照 Tashiro *et al.* 檢定加州圓介殼蟲性費洛蒙之轉盤裝置⁽¹⁶⁾，定製直徑 120 公分之木質圓形轉盤，將圓盤轉速定為 0.66 rpm，再將此轉盤置於上述飛行室環境條件下，及室外網室 ($5 \times 3 \times 2.5$ 公尺) 與番石榴園內，分別進行檢定試驗。

以圓形轉盤檢定不同蟲數，或不同日齡柑桔粉介殼蟲雌成蟲，及不同顏色黏膠板對雄成蟲誘引力之試驗時，其引誘源、黏膠板之製備及誘捕器之組合概依前述二及三(2)之方法製備。將欲測試之雌成蟲之蟲數、日齡，及性費洛蒙誘捕器所用之黏膠板顏色，以逢機、等距離平置於轉盤圓周邊上，另於圓心位置擺置一枚含有約 500~1000 隻 2~3 日齡雄成蟲之培養皿，餘如前述三(2)之方法進行檢定試驗。

四、柑桔粉介殼蟲雌成蟲對性費洛蒙反應之日周律試驗

先以 40 隻六日齡雌成蟲為誘引源與黏膠紙板組成誘捕器，再將 4 個誘捕器等距平置於轉盤圓周上，另於圓心位置擺置含 500 隻雄成蟲之培養皿一枚，試驗自下午四時開始，並於下午六時關燈，於隔夜翌晨六時開燈，照光後每隔 30 分鐘或 1 小時，記錄不同時段期間在誘捕器上被誘捕雄蟲數，如此連續觀察二日。

五、柑桔粉介殼蟲雌成蟲萃取液之誘引性試驗

以冰醋酸 (Glacial acetic acid)，無水酒精 (Absolute ethanol)，乙醚 (Diethyl ether)，丙酮 (Acetone)，二氯甲烷

(Dichloromethane), 及正己烷 (n-Hexane) 等六種不同溶劑各 1 ml 浸泡 200 隻八~九日齡處女雌蟲, 並將浸泡液置放 $6 \pm 2^\circ\text{C}$ 下約七天, 再以圓形轉盤法檢定萃取液之誘引性。檢定時係將不同溶劑萃取液各取 200 ul, 吸著於濾紙團上 (直徑 1 cm), 再將濾紙團置於黏膠板 (10×10 cm) 中央位置組成誘捕器, 依三(3)之方法進行萃取液之誘蟲活性檢定試驗。

結果與討論

一、柑桔粉介殼蟲性費洛蒙之生物檢定

(1) 不同日齡的柑桔粉介殼蟲雌成蟲對雄成蟲之誘引性

以培養皿、飛行室及圓形轉盤等三種方法, 分別進行檢定自 2 至 7 天, 及 0 至 15 天不同日齡柑桔粉介殼蟲雌成蟲對雄成蟲誘引性之結果如表一及二。三種方法檢定結果均顯示雌

性柑桔粉介殼蟲自脫皮為成蟲後, 隨日齡增長而對雄成蟲之誘引力有增強趨勢。但以培養皿法檢定時, 因供試雌成蟲日齡之間的差距不大 (表一), 或因培養皿檢定室空間狹小, 即使將供試雌蟲日齡之間的差距加大 (表二), 性費洛蒙氣味濃度仍易混淆, 致誘引源處理於每次測試結果變異極大, 經統計分析結果各處理間無顯著性差異。

以飛行室法檢定結果顯示雌成蟲日齡於 6~15 日間, 對雄成蟲之誘捕率無顯著性差異 (表二)。圓形轉盤法測試結果與飛行室檢定結果相似, 惟圓形轉盤生檢法檢定結果較飛行室者更為精確 (表二)。然圓形轉盤裝置擺置於網室內所做的檢定結果較不理想, 雌蟲日齡在 3~15 日間對雄蟲之誘引力無顯著性差異, 且在網室試驗時, 雄蟲被誘捕率僅為 11.8%, 較置於飛行室內的誘捕率 41.4% 差異甚大 (表二)。

表一、以培養皿法檢定 2 至 7 日齡柑桔粉介殼蟲雌成蟲對雄成蟲之誘引性

Table 1. Attractiveness of various ages of virgin females of *Planococcus citri* to males as assayed with petri-dish method.¹⁾

Age of virgin females (days)	% of total males attracted ²⁾
2	13.7± 5.7
3	14.6±10.1
4	12.8± 6.1
5	16.3± 5.6
6	18.2± 7.7
7	24.4± 9.8 n. s. ³⁾
Total males attracted ²⁾	49.8± 9.7

1) Groups of 40 virgin females in cage were provided as attracting sources and 100 males were released for each trial.

2) Mean±S.D. derived from 9 trials.

3) Data were transformed to arc sine \sqrt{x} prior to analysis, and no significant difference between means at 5% level according to Duncan's multiple range test.

表二、三種生物檢定法測試不同日齡柑桔粉介殼蟲雌成蟲對雄成蟲誘引力之比較結果
Table 2. Comparison of three methods for the testing of attractiveness of various ages of virgin females of *Planococcus citri* to males¹⁾

Bioassay method	% of total males attracted to traps baited with females of indicated age (days)					% males attracted	No. males flew away	
	0	3	6	9	12			15
Petri-dish ²⁾	13.2±5.4	9.2±4.4	17.2±9.9	17.1±8.7	23.4±13.4	19.7±9.5	55.1±11.8	100.0±0
.....								
Free-flight room ³⁾	2.6±1.3	11.1±8.2	14.3±4.3	23.1±17.2	27.6±6.2	21.1±9.8	48.9±17.4	417.5±56.1
.....								
Turntable in screened house ³⁾	2.5±1.8	18.9±2.7	17.7±4.2	23.5±6.6	20.3±11.1	16.7±3.2	11.8±4.2	430.3±39.8
.....								
in flight room ³⁾	2.3±1.9	12.7±1.9	17.8±4.8	21.6±6.1	23.0±5.6	22.6±6.4	41.4±18.9	443.8±76.7
.....								

1) Groups of 40 virgin females in cage were provided as attracting source.

2) Mean±S.D. derived from 8 trials. Data were transformed to arc sine \sqrt{x} prior to analysis, and no significant difference between means at the 5% level according to Duncan's multiple range test.

3) Mean±S.D. derived from 4, 4, 10 trials for free-flight room, turntable in screened house and in flight room method, respectively. Data were transformed to arc sine \sqrt{x} prior to analysis, and means (reading horizontally) followed by the same letters were not significantly different at the 5% level according to Duncan's multiple range test.

以圓形轉盤法進一步測試15~30及0~30日齡柑桔粉介殼蟲雌成蟲對雄成蟲之誘引性結果如表三與四。表三顯示15~30日齡雌成蟲對雄成蟲之誘引力無顯著性之差異。表四則顯示雌性柑桔粉介殼蟲最後一次脫皮當天，即0日齡雌成蟲對雄成蟲之誘引力甚小，僅有1.6

%，但隨雌蟲日齡增長，其誘引力有增強趨勢，以12日齡者誘引力最強，達23.6%，其後隨雌蟲日齡之老化，誘引力却有降低之趨勢，惟在6~18日齡之雌蟲，其誘引力無顯著性差異，此與前述試驗結果類似。

表三、以轉盤飛行室法檢定15至30日齡柑桔粉介殼蟲雌成蟲(40隻)對雄成蟲之誘引性
Table 3. Attractiveness of various ages of 40 virgin females of *Planococcus citri* to males as assayed with turntable olfactometer in flight room.

Age of virgin females (days)	% of total males attracted ¹⁾
15	17.6±2.9
18	16.8±2.5
21	16.7±4.6
24	16.3±2.9
27	16.2±2.7
30	16.4±3.2 n.s. ²⁾
Total males attracted ¹⁾	328.8±28.5

1) Mean±S.D. derived from 8 trials. Mean (±S.D.) number of males flew away for each trial was 437.8±62.2.

2) The same as table 1.

表四、以轉盤飛行室法檢定0至30日齡柑桔粉介殼蟲雌成蟲(40隻)對雄成蟲之誘引性
Table 4. Attractiveness of various ages of 40 virgin females of *Planococcus citri* to males as assayed with turntable olfactometer in flight room.

Age of virgin females (days)	% of total males attracted ¹⁾
0	1.6±0.3 ²⁾ d
6	21.2±2.0 ab
12	23.6±3.6 a
18	20.0±2.3 abc
24	17.0±2.5 bc
30	16.6±3.4 c
Total males attracted ¹⁾	336.0±30.9

1) Mean±S.D. derived from 4 trials. Mean (±S.D.) number of males flew away for each trials was 448.0±60.4.

2) Data were transformed to arc sine \sqrt{x} prior to analysis, and means followed by the same letters were not significantly different at the 5% level according to Duncan's multiple range test.

(2) 不同蟲數的柑桔粉介殼蟲雌成蟲對雄成蟲之誘引性

以培養皿、飛行室及圓形轉盤等三種方法，分別進行檢定自 0 至 160 隻不同蟲數柑桔粉介殼蟲雌成蟲對雄成蟲誘引性之結果如表五及六。三種方法檢定結果均顯示柑桔粉介殼蟲雌成蟲隨蟲數增多對雄成蟲之誘引力有增強之趨勢。以培養皿法檢定時，於經一宿後觀察結果，自 20 至 160 隻雌蟲對雄蟲之誘捕率無顯著性差異 (表五)；惟經二日後觀察各誘引源捕獲雄蟲率之結果，則以 40 至 160 隻雌蟲對雄蟲之

誘捕率無顯性差異，並與經三或四日後觀察之結果雷同；另外隨處理時間延長，雄蟲被誘捕率有增加趨勢 (36.1% 增為 83.2%) (表五)。因此，以培養皿法檢定柑桔粉介殼蟲性費洛蒙誘引性時，可經二日再觀察試驗結果較佳。但培養皿法檢定之效果仍較其他方法者為差，例如不含雌成蟲之空白誘引源對雄成蟲誘捕率高達 5.4% (二日後結果)，與以 10 隻雌蟲為誘引源時之誘捕率 (8.4%) 無顯著性差異，似因此法所用空間狹小，致試驗時性費洛蒙氣味濃度易混淆於培養皿中，影響試驗之結果。

表五、以培養皿法檢定不同蟲數柑桔粉介殼蟲雌成蟲 (6 日齡) 對雄成蟲之誘引性

Table 5. Attractiveness of various numbers of 6 days old virgin females of *Planococcus citri* to males as assayed with petri-dish method.

Days after treatment	% of total males attracted to cages containing indicated no. of females ¹⁾						% males attracted ¹⁾
	0	10	20	40	80	160	
1	7.4±6.8 c	10.0±5.9 bc	20.1±12.9 ab	17.8±12.8 ab	22.6±12.2 a	22.1±10.5 ²⁾ a	36.1±22.6
2	5.4±3.4 c	8.4±5.5 c	16.0±5.4 b	18.9±9.9 ab	23.7±8.7 ab	27.3±4.0 a	70.6±15.2
3	5.8±3.4 c	8.8±5.1 c	16.3±4.7 b	20.0±7.3 ab	22.8±8.1 ab	26.1±9.7 a	81.1±12.5
4	5.6±3.4 c	8.6±5.0 c	16.1±4.6 b	19.9±7.2 ab	23.2±8.1 ab	26.6±9.6 a	83.2±14.1

1) Mean±S.D. derived from 9 trials, and 100 males initially released in each trial.

2) Data were transformed to arc sine $\sqrt{\frac{x}{n}}$ prior to analysis, and means (reading horizontally) followed by the same letter were not significantly different at the 5% level according to Duncan's multiple range test.

以飛行室法檢定結果顯示柑桔粉介殼蟲雌成蟲隨供試蟲數之增加，其對雄成蟲之誘引力有增強之趨勢，供試蟲數增加到 40 隻後誘捕率並無顯著的增加 (表六)。改以圓形轉盤法測試結果則雌蟲蟲數於 80 隻以上時，對雄蟲之誘捕率無顯著性差異 (表六)。因此圓形轉盤法之檢定效果較其他方法為優，同時以 40 隻以上、6 日齡處女雌蟲將是最省工又省時的誘引源。

(3) 不同顏色黏膠板對雄成蟲之誘引性

柑桔粉介殼蟲性費洛蒙誘捕器配合六種不同顏色黏膠板時，經以飛行室及圓形轉盤法檢定其對雄成蟲之誘捕力結果如表七。以飛行室法檢測六種顏色性費洛蒙誘捕器對雄蟲之誘捕率，依序為紅>綠>黑>白>藍>黃，然經統計分析，各處理間無顯著性差異 (表七)。改以圓形轉盤法檢測結果，六種顏色黏膠板誘捕器之誘捕力，依序為紅>黑>綠>黃>藍>白，與飛行室法檢測結果有雷同之趨勢 (表七)

表六、三種生物檢定法測試不同蟲數柑桔粉介殼蟲雌成蟲 (6 日齡) 對雄成蟲誘引力之比較結果
 Table 6. Comparison of three methods for the testing of attractiveness of various numbers of 6 days old virgin females of *Planococcus citri* to males.

Bioassay method	% of total males attracted to traps baited with indicated no. of females						% males attracted	No. males flew away
	0	10	20	40	80	160		
Petri-dish ¹⁾	7.4±6.8	10.0±5.9	20.1±12.9	17.8±12.8	22.6±12.2	22.1±10.5	36.1±22.6	100.0±0
.....	c	bc	ab	ab	a	a		
Free-flight room ¹⁾	1.5±1.5	11.4±3.7	15.0±3.0	19.9±13.2	20.6±3.2	31.6±14.4	30.6±11.1	388.0±98.6
.....	c	b	b	ab	ab	a		
Turntable in ¹⁾	1.1±1.4	11.0±3.4	13.9±2.7	21.0±1.3	25.3±2.9	27.8±4.6	51.5±16.3	418.0±97.3
flight room	d	c	c	b	ab	a		

1) Mean±S.D. derived from 9, 4, 8 trials for petri-dish, free-flight room and turntable in flight room method, respectively. Data were transformed to arc sine \sqrt{x} prior to analysis, and means (reading horizontally) followed by the same letters were not significantly different at the 5% level according to Duncan's multiple range test.

表七、二種生物檢定法測試不同顏色黏膠板 (含40隻6日齡柑桔粉介殼蟲雌成蟲) 對雌成蟲誘引力之比較結果
 Table 7. Comparison of two methods for the testing of attractiveness of various colored trap cards baited with forty 6-day-old virgin females of *Planococcus citri* to males.

Bioassay method	% of total males attracted to various colored trap cards					% males attracted	No. males flew away	
	Red	Yellow	Green	Blue	White			Black
Free-flight room ¹⁾	20.0±7.2	13.9±7.9	18.4±6.7	14.4±6.9	16.2±8.5	17.1±10.9	31.4±8.0	274.8±28.8
.....								
.....				n. s.				
.....								
Turntable in flight room ²⁾	22.7±4.0	15.4±3.8	16.6±3.1	14.1±2.8	13.1±4.2	18.2±3.8	60.4±19.8	432.6±45.6
.....	a	bcd	bc	cd	d	b		
.....								
.....								
in guava orchard ²⁾	20.8±4.2	17.9±7.0	11.4±4.9	19.1±9.7	15.5±6.0	13.4±2.6	18.2±7.5	864.5±43.8
.....	a	ab	c	ab	abc	bc		

1) Mean±S.D. derived from 5 trials. Data were transformed to arc sine \sqrt{x} prior to analysis, and no significant difference between means at the 5% level according to Duncan's multiple range test.

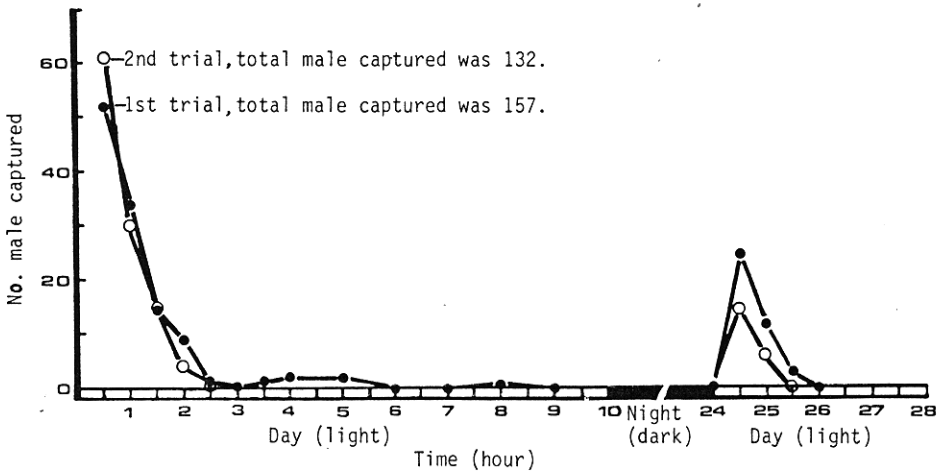
2) Mean±S.D. derived from 14,10 trials for turntable in flight room and in guava orchard, respectively. Data were transformed to arc sine \sqrt{x} prior to analysis, and means (reading horizontally) followed by the same letters were not significantly different at the 5% level according to Duncan's multiple range test.

。即紅色黏膠板最具誘捕力，其次則為黑或綠色，而黃、藍、白色之誘捕力無顯著性差異。再於番石榴園擺置圓形轉盤測試結果，仍顯示紅色黏膠板具顯著性誘雄效力，而藍、黃、白顏色之誘雄效果居中，黑及綠色之誘捕力變為最差，惟無顯著性之差異(表七)。以上室內與野外檢定之結果頗為一致，顯示圓形轉盤生檢法之再現性(Reproductivity)頗佳，而外界環境因子對雄蟲對顏色黏膠板之反應無明顯之影響。Negishi *et al.*⁽¹⁰⁾曾於室內檢定桑粉介殼蟲(*Comstock mealybug, Pseudococcus comstocki* Kuwana)性費洛蒙誘蟲器之顏色對雄蟲的誘捕力，依序為紅=暗綠=黑>綠>黃>白，其結果與本試驗者相似。另曾以未配上柑桔粉介殼蟲雌成蟲為誘引源的六種顏色黏

膠板，測試對雄成蟲之誘引性，結果無法誘捕到雄蟲，故知顏色黏膠板本身對雄蟲不具誘引性，須與雌成蟲組合，始具誘捕雄蟲能力。

二、柑桔粉介殼蟲雄成蟲對雌性費洛蒙反應之日周律

柑桔粉介殼蟲雄成蟲於開燈後30分鐘內被雌成蟲誘捕的蟲數最多(圖一)，其後隨開燈時間延長，雄蟲被誘捕數急減，於開燈2小時以後，甚少雄蟲被誘捕；又在關燈(晚間)期間內，全無雄蟲被誘捕，須於次日開燈後，雄蟲再度對雌性費洛蒙有反應。桑粉介殼蟲雄成蟲對雌性費洛蒙反應之行為亦有相同的型式⁽¹⁰⁾。依本試驗結果，在檢定柑桔粉介殼蟲性費洛蒙誘蟲活性時，以開燈後立刻進行為宜，而在開燈2小時以後，即可觀察檢定結果。



圖一、柑桔粉介殼蟲雄成蟲對雌性費洛蒙誘捕器反應之日飛行模式

Fig. 1. Diurnal flight patterns of *Planococcus citri* males attracted to females-baited traps. Initial males released were 500, and 2 consecutive days were observed.

三、柑桔粉介殼蟲處女雌蟲萃取液之誘引性

六種溶劑浸漬柑桔粉介殼蟲處女雌蟲之粗萃取液對雄蟲之誘引性如表八。以冰醋酸之萃取液最具誘雄活性，其次為無水酒精，其他溶劑如正己烷、二氯甲烷、乙醚、及丙酮等之萃取液之誘雄活性則較差。Rotundo & Tremblay 報告⁽¹²⁾以無水酒精、乙醚或石油醚(Petroleum ether)萃取柑桔粉介殼蟲性費洛蒙較具誘

引性，但甲苯(Toluene)、正己烷及正戊烷則無法萃取到性費洛蒙。Gravitz & Willson⁽⁷⁾則稱該粉介殼蟲性費洛蒙可以正戊烷萃取。若將來欲以溶劑大量萃取柑桔粉介殼蟲性費洛蒙，以進行性費洛蒙組成份鑑定時，可暫以冰醋酸或無水酒精為溶媒，浸漬該粉介殼蟲雌成蟲，供性費洛蒙研究之蟲材。

表八、不同溶劑之柑桔粉介殼蟲處女蟲萃取液對雄成蟲之誘引性

Table 8. Percentage of *Planococcus citri* males responding to solvent extracts of uncrushed virgin females on filter paper rolls.

Solvents	% of total males attracted ¹⁾
Glacial acetic acid	34.3±20.2 ²⁾ a
Absolute ethanol	20.5±12.1 b
Diethyl ether	10.5± 7.2 b
Acetone	10.5± 5.4 b
Dichloromethane	11.4± 3.9 b
n-Hexane	12.8± 6.6 b
Total males attracted ¹⁾	479.4±269.3

1) Mean±S.D. derived from 9 trials.

2) Data were transformed to arc sine \sqrt{x} prior to analysis, and means followed by the same letters were not significantly different at the 5% level according to Duncan's multiple range test.

結 論

關於柑桔粉介殼蟲性費洛蒙生物檢定方法，經以培養皿法、飛行室法及圓形轉盤法檢定比較結果，以培養皿法檢定之效果最差，對不同日齡雌性柑桔粉介殼蟲之誘引力，無法呈現顯著差異（表二），其在檢定不同蟲數雌性柑桔粉介殼蟲之誘引力時，處理間區分辨離效果亦不如飛行室法及圓形轉盤法（表六）。飛行室法檢定之能力屆中，惟在檢定不同顏色黏膠板之誘引力時，無法呈現顯著性差異（表七）。圓形轉盤法之檢定效果最佳，此或由於轉盤檢定室之空間較大，可避免培養皿法因檢定空間狹小，易造成所揮散性費洛蒙充滿試驗空間內，致處理間誘引性無法區分之結果。同時轉盤具隨時改變誘引源位置之特性，可消除飛行室因誘引源位置固定，可能產生的方位偏好效應，而使處理間誘引性不易區分之現象。轉盤檢定法在測試加州圓介殼蟲 (*California red scale, Aonidiella aurantii* (Maskell))⁽¹⁶⁾，黃圓介殼蟲 (Yellow scale, *Aonidiella citrina* (Coquillett))⁽⁶⁾，梨圓介殼蟲 (San Jose scale, *Quadraspidiotus perniciosus* (Comstock))⁽⁶⁾及桑粉介殼蟲⁽³⁾雌性費洛蒙對

雄成蟲誘引力之試驗，均曾顯現可信賴的結果，因此轉盤檢定法應可作為未來測試柑桔粉介殼蟲性費洛蒙之標準檢定方法，其亦可適用於其他介殼蟲類或習性近似之小型昆蟲類性費洛蒙之檢定工作。

柑桔粉介殼蟲處女雌蟲之誘引性，經生物檢定結果亦顯示：6~18日齡，及40隻以上雌成蟲對雄成蟲極具誘引之能力，此種標準化的處女雌蟲誘引性，在商品化合成性費洛蒙劑未出現前，可嘗試用於果園偵測該粉介殼蟲族群之發生、消長狀況，以適時提供有關防治該粉介殼蟲之情報。Rice & Jones及Shaw *et al.*亦曾利用梨圓介殼蟲及加州圓介殼蟲之處女雌蟲與黏膠板組成費洛蒙誘捕器，來偵測介殼蟲分佈為害地區，及發生消長狀況，作為適期施用藥劑之依據^(11,13)。另外，標準化的處女雌蟲之誘引性資料，將來在檢定合成性費洛蒙劑時，可做為對照參考資料。

紅顏色黏膠板之誘捕器，誘捕雄成蟲的效率較其他顏色者為大，故未來在設計開發粉介殼蟲性費洛蒙誘捕器時，宜將誘捕器之顏色可能增強誘捕器誘蟲之效應列入考慮。

柑桔粉介殼蟲雌成蟲之飛行及其對雌性費洛蒙之反應，明顯地受光照條件的影響，雄蟲

在黑暗期間(晚間)不飛翔並且不對費洛蒙發生反應,但於開燈時,雄蟲立即自由飛翔,並可被雌性費洛蒙誘捕器誘捕,在開燈後2小時內,雄蟲被誘捕數最多,以後雄蟲幾不飛翔或對雌性費洛蒙誘捕器發生反應,故在檢定該粉介殼蟲性費洛蒙誘捕器時,宜於開燈後2小時內進行測試觀察,即可得到高準確度的結果。數種有機溶劑浸漬柑桔粉介殼蟲雌成蟲之粗萃取液,經檢定其誘蟲活性之結果,以冰醋酸或無水酒精之雌成蟲浸漬液最具誘雄活性,此有助於未來分離、純化、及鑑定柑桔粉介殼蟲性費洛蒙組成份的研究工作。

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