出國報告（出國類別：其它）

第六屆亞太昆蟲學會年會

服務機關：行政院農委會農業試驗所
姓名職稱：副研究員 高靜華
助理研究員 余志儒
助理研究員 黃毓斌
派赴國家：中國
出國期間：98 年 10 月 18 日~98 年 10 月 22 日
報告日期：99 年 1 月 6 日

摘要:

職等參與本屆亞太昆蟲年會除了發表東方果實蠅在四種寄主水果上兩性生命表、以生命表評估瓢蟲成蟲性比例與密度對族群的影響等研究，另外亦就本國瓜實蠅防治現況作一個報導，同時以兩性生命的觀點，就天敵的性比、密度及拋棄年齡研究展示成果，以及與長期生態較有關係的議題，如 Functional agrobiodiversity (FAB，功能性農業生物多樣化)、Insect ecology (昆蟲生態) 與 Conversation, biodiversity and climate change (保育、生物多樣性與氣候變遷) 等，和與會人士進行學術交流。

目的：

亞太昆蟲學會年會是亞太地區昆蟲學界最高層級盛會，每四年舉辦一次，亞太地區 17 個國家昆蟲研究者齊聚一堂，交流最新的研究成果。本屆於中國北京市九華山莊舉行，爲期 5 天。2009 年大會主題係昆蟲學對人類健康、農業及環境之影響(Entomology in Health, Agriculture and Environment)，藉由年會之舉辦，與昆蟲學領域的研究人員，交換最新研究心得，擴大視野。

內容:

舉行日期爲 2009 年 10 月 18 日至 2009 年 10 月 22 日，地點爲北京市九華山莊第 16 區。會議行程如下：

第一天 （10/ 18）:會員註冊報到及領取資料，會員來自日本、韓國、中國、美國、澳洲、印度、印尼、馬來西亞、泰國、越南、新加坡及台灣。本屆我國共有中興大學昆蟲系、大仁技術學院、農業試驗所等單位報名參加論文宣讀及壁報展示。本次大會安排了 3 個住宿區，分別爲 9、10 及 16 區，會場設於 16 區，2 樓及 3 樓爲主要研討會會場，9 及 10 區可搭輕軌車或走路到會場。

第二天 （10/19)開幕典禮

今天開幕由大會主席宣布，本屆由大陸代表主持宣讀歡迎會員國代表出席，近中午午餐時間大會安排團體照，本屆大會邀請 5 位來自美國、日本、中國、澳洲及韓國等學者發表論文報告，全體會員參加，主題及報告內容分別如下:

1. **Insect life at the Extreme: Surviving in Antarctica**，演講者爲來自美國教授 David L. Denlinger 博士，這個團隊探討在極地上節肢動物如 1 種小型搖蚊(chironomid midge)的幼蟲，如何在此極惡劣之環境存活下來。Dr. Denlinger 模擬極地環境飼養搖蚊幼蟲，歷經兩年後成功飼養化蛹、蛻變及與畫成無翅型成蟲，進而發育至成蟲交尾產卵後死亡，完成世代。試驗目標就是要去找出這種生理機制，首要問題須解決要去 heat shock

proteins 的基因解碼，另一個問題就體內水含量流失之問題，大部分昆蟲僅能忍受 20~30%之水含量流失，但這種搖蚊幼蟲在體內水分流失至 70%時仍可存活。由於這是第一次極地上昆蟲存活探討，吸引大家的討論。

2. **Recent Progress on the Molecular Mechanisms of Juvenile Hormone Biosynthesis and Action**：演講者為來自日本的學者 Tetsuro Shinoda 博士，有關 Juvenile hormone 之研究，長久以來日本一直居於領先地位。以分子生物的技術就最近兩個 JH 合成時之 critical gene 提出探討，一個是 JH 生物合成酵素(Biosynthesis enzyme) JHAMT(JH acid O-methyltransferase)，另一個為 JH 信號分子 KrÜppel homolog 1（Kr-h1）。一般說來，JH 是由咽喉側腺所早期合成路徑分泌，而 JHAMT 則是生物合成反應之後期路徑，可催化生物反應 JH acid 或 farnesoic acid (FA)轉變成 methylfarnesoate(MF)。Tetsuro 博士利用家蠶、果蠅、斑蚊及天牛等昆蟲複製 JHAMT 基因。此複製基因在每種昆蟲上之咽喉側腺均有高度表現能力，轉譯能力也與血球上 JH 或生物合成反應有密切關係。另外他們也發現利用天牛複製基因 Kr-h1 及使用 RNAi 研究其幼蟲期信號傳遞 endogenous JH 之 功能。
3. **Linkage of Chemical Information through Tritrophic System**:化學信息在三級營系統中的聯繫，由中國科學院康東研究員擔任演講，他探討了植物-植食性昆蟲-寄生者三級營養結構之間，由於長期相互適應和趨同演化，產生了一系列獨特的相互關係。
4. **Insect Climate Specialists and Generalists**：由澳洲墨爾本大學的 Ary Hoffmann 教授就氣候對昆蟲的專一食性者(specialists)及廣食性(generalists)者發表報告，其研究顯示 Drosophila 屬對於乾燥及寒冷的抗性，專一食性者有較小的變異範圍，廣食性者則有較大的變異程度。這種結果與 DNA decay 假說的符合性是沒有關係的。昆蟲專一食性者主要的策略是缺乏遺傳變異，以便限制超過其適應的能力，Hoffmann 預測這些專食性種類未來可能會被氣候變遷限制於演化反應。
5. **Insect Host and Parasite: Molecular Interactions and their Applications**： 由韓國安東大學 Yonggyun Kim 教授以昆蟲寄主與寄生者間之分子上的交互作用論述及其未來應用於微生物農藥製劑之研究題目於會中發表論文。Yonggyun Kim 教授認為大部份病毒引起的基因(viral gene)會藉由非自我辨識降低其免疫反應，抑制基因的表現或重組。這種抑制免疫力 polydnaviral 基因近來已應用於可產生重新組合 nucleopolyedrosis 的病毒，使其能夠有效地防治害蟲。這種源自於細菌或病毒的抑制免疫力製劑，提升微生物農藥殺蟲效能，這個論點利用寄主昆蟲抑制免疫力提供了現在使用微生物製劑策略上的補充證據。

第三天(10/20)及第四天(10/21)

本屆大會規劃了 17 個研討會單元，共有 244 篇論文宣讀，兩天分成 7 個研討室進行論文宣讀與討論，由與會人員自由參加，基本上每人報告 15~20 分鐘，主持人開放 1~2 個問題討論。另外大會有 189 篇壁報展示之介紹，開放與會人員隨時討論。

1. **Sustainable Management of Pest Insects**：18 篇口頭報告，21 篇壁報展示。
2. **Pesticides, Resistance and Toxicology**：18 篇口頭報告，23 篇壁報展示。
3. **Urban, Stored product and Post Harvest Entomology**：11 篇口頭報告，6 篇壁報展示。
4. **Insect Ecology**： 11 篇口頭報告及 16 篇壁報展示。
5. **Genetics, Genomics, Transgenics and Evolutionary Biology**：16 篇口頭報告，6 篇壁報展示。
6. **Insect Pathology, Parasitology and Biological Control**：17 篇口頭報告，14 篇壁報展示。
7. **Medical and Veterinary Entomology**：12 篇口頭報告，9 篇壁報展示。
8. **Development and Metamorphosis**：15 篇口頭報告，2 篇壁報展示。
9. **Physiology and Biochemistry**：15 篇口頭報告，15 篇壁報展示。
10. **Insect Behavior and Invasive species**：18 篇口頭報告，14 篇壁報展示。
11. **Systematics, Phylogeny and Zoogeography**：9 篇口頭報告，22 篇壁報展示。
12. **Conservation, Biodiversity and Climate Change**：8 篇口頭報告，5 篇壁報展示。
13. **Insect-Plant interactions**：9 篇口頭報告，6 篇壁報展示。
14. **Proximity and Prospect on Cisgenic and Transgenic Insect Resistance Research in crop plants**：8 篇口頭報告。
15. **Functional Agrobiodiversity**： 17 篇口頭報告，21 篇壁報展示。
16. **Management of Tephritid fruit flies**：8 篇口頭報告。
17. **Vector Surveillance and Control**：19 篇口頭報告。

第五天(10/22)

會員賦歸或自由參加旅遊，第七屆亞太昆虫學大會將在印度舉行。

參加心得：

本所三位研究人員黃毓斌、余志儒及高靜華分別參與了口頭報告及壁報展示，內容摘要及檔案如附件一、二、三。心得分述如下:

演講中提述了東方果實蠅(*Bactrocera dorsalis*)是亞太地區最具破壞性之檢疫害蟲，在台灣可爲害之寄主達 150 種以上，爲了建立果實蠅之生態資料，本研究探討了東方果實蠅在四種寄主水果，番石榴、印度棗、蓮霧及柚子上之發育、存活及繁殖率。生活史資料以 age-stage, two sex life table 分析，試驗結果顯示，其在四種寄主水果之內在增殖率(r)分別爲 0.1311, 0.1168, 0.1058 及 0.1168 (1/day)，淨生殖率(R_0)分別爲 453.7, 689.9, 303.8, 及 408.5(eggs)，其數值大小對於爲害風險有關。與會人士對兩性生命表很有興趣，曾於會中提出討論。本屆至少有 6 篇關於生命表的研究，兩性生命表仍是主流，昆蟲生態單元除生活史的探討外，食物取食、營養、環境溫度及光週期對發育及存活均爲本單元討論主題。

本次會議主要分口頭報告與海報兩部份，口頭報告有 17 個單元分別在 10 月 20、21 日完成，所以只能選擇性參加。與長期生態較有關係的單元，在 20 日的爲 Functional agrobiodiversity (FAB，功能性農業生物多樣化)，計有 17 篇，海報 21 幅。21 日上下午分別爲 Insect ecology (昆蟲生理) 與 Conversation, biodiversity and climate change (保育、生物多樣性與氣候變遷) 兩單元，口頭報告分別有 11 與 8 篇，海報分別有 16 與 5 幅。

功能性農業生物多樣化 (FAB) 單元中發表最多的國家是日本，17 篇口頭報告中就佔了 10 篇，其次爲中國有 4 篇，餘爲英國、馬來西亞及捷克，台灣無。海報方面，此單元的 21 幅中只有 2 幅是中國的，其餘清一色爲日本學者所發表。所謂 FAB，是透過農業區域中生物多樣性的營造，達到對環境、對人類有益的目的。其中對作物害蟲的生物防治與作物的傳粉爲最常被挹注的 2 個生態系。例如，透過保育以豐富的多樣化、強化生物天敵對害蟲的抑制效果，進而減少化學農藥對生態環境的衝擊。荷蘭在 2007 年就有特別著重於增加生物天敵冬季棲所與成蟲食物方面有效性的研究計畫，而 2008 年日本也開始了全國性的 FAB 研究。但一個生態系中生物相繁雜，爲提高評估效率，有必要以指標生作爲物提綱挈領。此議題中就有多篇在討論指標生物的選擇，期望指標生物能真實反應 FAB 的效果。而指標生物的決定，通常以普查資料做爲基礎，會有較客觀的判斷。日本 Tadashi Ishikawa 等人就以先透過田間調查，列出水田的昆蟲相清單爲第一步，才去選立 FAB 的指標生物種類。其報告中列出約 83 科 340 種的節肢動物，選了 9 個種或種群做爲有潛力的指標生物，而這 9 個種或種群大致上都是優勢種。

捕食性瓢蟲也是常被選爲 FAB 指標生物的一群，上述 Tadashi Ishikawa 等人的報告就選了 *Scymmus hoffmanni* 爲具潛力的指表生物之一。另舉中國學者的報告爲例。王正營(Zhengying Wang) 等人用捕食性瓢蟲爲指標生物，評估 Bt 轉殖玉米對生物天敵的影響。連續數年的田間調查結果，顯示 Bt 轉殖玉米田與非 Bt 轉殖玉米田之間在瓢蟲

類數與數量上略有不同，但爲春季優勢種的龜紋瓢蟲 (*Propylaea jabonica*)，夏季的龜紋瓢蟲與異色瓢蟲 (*Harmonia axyridis*)，其族群動態在 Bt 轉殖與非 Bt 轉殖玉米田之間卻無顯著差異，而認爲 Bt 的 CrylAb 毒素對捕食性瓢蟲無影響，可應用於害蟲綜合管理體系中。Ono 在其海報中，指出食蚜瓢蟲也是很好的指標生物之一，因大麥上的黍蚜 (*Rhopalosiphum padi*) 是生物天敵的食物源，使發揮對大豆上蚜蟲 (*Aulacorthum solani*) 族群的抑制，而肯定了大豆混植大麥這種耕作方式的益處。

Insect ecology 屬於比較基礎性質的研究，由於生命表是反應生物在某生長條件下族群消長的重要資訊，在生態學研究上至爲重要。此單元中有關生命表的口頭報告有 2 篇、海報 3 篇，來自台灣的分別有 1、2 篇。在 Conversation, biodiversity and climate change 單元中，最關注的還是全球氣候暖化影響生物特性與生物相結構的問題，此與長期生態的研究關係密切。氣候變遷可能改變海水位、降雨、乾旱、河流水文等，自然會對生態系造成影響。會中 Tetsuo Harada 等人對在日本 Kochi prefecture 地區水黽 (*Aquarius paludum*)有超過 20 年的研究觀察，其生活史隨著氣候暖化而有了變化。Parajulee 等人指出因爲全球暖化提高大氣中的二氧化碳量，影響棉花農業生態系中三營養階層 (作物、食植性生物及其天敵) 的交互作用。Kameshiro 等人的海報顯示營養階層高的生物被影響更明顯，所以認爲用生物天敵作爲指標生物具有意義。

在上述幾個與長期生態較有關的單元上，尤其是生物多樣性，日本與中國皆著力很多，可見生態保育已是舉世的共識。農業長期生態研究是長期生態研究的一環，希望以最低衝擊的投入去永續經營農耕環境，除了穩定農業生態系的生物多樣性之外，也同時能獲得農業生產及對有害生物的抑制。因此，大多將強化生物防治與自然授粉列爲首要目標。本計畫是國內農業長期生態研究中的子計畫之一，旨在藉由監測主要病、蟲害及生物天敵在田間的族群消長，瞭解不同農耕投入操作對生物相的影響。監測的病、蟲害正如前述是以優勢種類爲主，另外也以捕食性天敵的食蚜瓢蟲類做爲監測的指標生物。指標生物的決定，是以文獻記載爲依據，由於全球氣候暖化的影響，田間生物相可能有所改變，故指標生物的代表性有賴全面的普查資料再強化。

本次年會期間參與「果實蠅類蟲害管理」研討會時，與來自美國的 Drs. Ronald Mau, Roger Vargas, John Stark 等人在 10 月 18 日先行聚會及討論。10 月 21 日另有日本沖繩縣的松山隆志研究員、夏威夷大學博士生周明儀、大陸福建農林大學季清娥博士、華中農業大學牛長纓博士等人加入，共同進行論文發表，對於新類型誘引劑之研發應用、

新類型化學藥劑的防治效能評估、區域防治概念在各國之推展現況等，充分交流研究概況與資訊，也趁便瞭解大陸主要危害的果實蠅種類及其防治研究進展，並與各國研究人員建立未來合作研究的溝通管道。

另外在「農藥、抗藥性及毒理」研討會部分，計有 19 位研究人員發表論文，研究對象含入侵紅火蟻、家蠅、家蠶、書蝨、介殼蟲、斑潛蠅、斜紋夜蛾、二點葉蟎，以及多種馬鈴薯、穀類、小麥及水稻的害蟲。研究內容包括利用分子生物學進行品種鑑定；抗藥性機制研究；植物精油、粉末及其萃取液對於產卵抑制、忌避及殺蟲效能研究等。「衛生及畜牧害蟲」研討會部分也有 16 篇論文發表，對於斑蚊類、蝨類、沙蠅等吸血性昆蟲之傳病機制、分布、診斷、遺傳特性及藥劑防治研究等在亞非地區之進展，亦有詳盡報告，爲此次規模較大且規劃最完善的研討會。

建議：

國內的植物保護研究雖已具相當基礎，但與幅員廣大的其他國家相比較，各領域的研究人員相對的較少，能涵蓋及交流的研究範圍有限。建議多參與區域性或全球性的研討會可以擴展視野，認識相同領域的學者專家，建立學術交流管道，對於加強研究發展及擴大研究領域等，頗有助益。藉由資訊交流可借鏡國外現有的研發成果，適時調整研究方向，可達事半功倍之效。

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附圖 參加第六屆亞太昆蟲年會現場花絮

附錄

附件一：

Population Parameters of the Oriental Fruit Fly (Diptera: Tephritidae) Reared on Four Host Plants

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The oriental fruit fly (*Bactrocera dorsalis* Hendel), one of the most destructive pests in the Asia-Pacific area and the most important quarantine pest for many countries, attacks more than 150 cultivated and wild fruits in Taiwan. To establish an ecological database, we studied the development, survival and fecundity of *B. dorsalis* reared on four host plants, i.e., guava (*Psidium guajava* L.), Indian jujube (*Zizyphus mauritiana* L.), wax apple (*Syzygium samarangense* Merr. & Perry) and pomelo (*Citrus grandis* Osbeck), at 25±1°C, R.H. 70±10%, and a photoperiod of 12: 12 (L: D). The life history raw data were analyzed based on the age-stage, two-sex life table. The intrinsic rate of increase (r) was 0.1311, 0.1168, 0.1058 and 0.1168 on guava, Indian jujube, wax apple, and pomelo, respectively. The net reproductive rate (R_0) was 453.7, 689.9, 303.8, and 408.5 on guava, Indian jujube, wax apple, and pomelo , respectively.

Key words: Oriental fruit fly, Host plant, Population parameter

Aluja, M. and mangan, R. L, 2008. Fruit fly (Diptera: Tephritidae) host status determination: critical conceptual, methodological, and regulatory considerations. Ann. Rev. Entomol. 53: 473-502.

Chi, H. 1988. Life-table analysis incorporating both sexes and variable development rates among individuals. Environ. Entomol. 17: 26-34.

Population Parameters of the Oriental Fruit Fly (Diptera: Tephritidae) Reared on Four Host Plants

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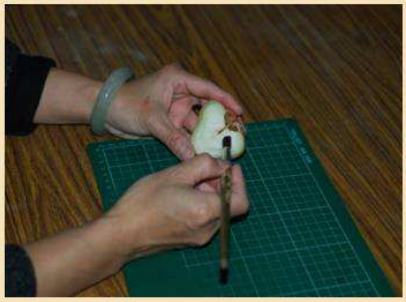
Guava (*Psidium guajava* L.)

Wax apple (*Syzygium samarangense* Merr. & Perry)

Pomelo (*Citrus grandis* L.)

Indian jujube (*Ziziphus mauritiana* Lam)

Materials and Methods



Egg inoculation

Rearing container

Fruit piece renewed daily

Daily fecundity collection

Paired male and female on rearing container

Rinse out eggs

Count eggs under binocular

Raw Data Analysis

- The life history raw data were analyzed based on the age-stage, two-sex life table. The means and standard errors of the life table parameters were estimated by using the Jackknife method.
- The population parameters include intrinsic rate of increase (r), finite rate of increase (λ), gross reproductive rate (GRR), net reproductive rate (R_0), and mean generation time (T).

- **Net reproductive rate:** $R_0 = \sum l_x m_x$
- **Intrinsic rate of population increase:** $\sum e^{-r(x+1)} l_x m_x = 1$
- **Finite rate of increase :** $\lambda = e^r$
- **Mean Generation time:** $T = \frac{\ln R_0}{r}$

(Cited by Goodman , 1982)

TWOSEX program

- A computer program TWOSEX-MSChart for the age-stage, two-sex life table analysis for Windows system is available at http://140.120.197.173/Ecology/prod02.htm (Chung Hsing University, Taichung, Taiwan) and http://nhsbig.inhs.uiuc.edu/wes/chi.html (Illinois Natural History Survey).

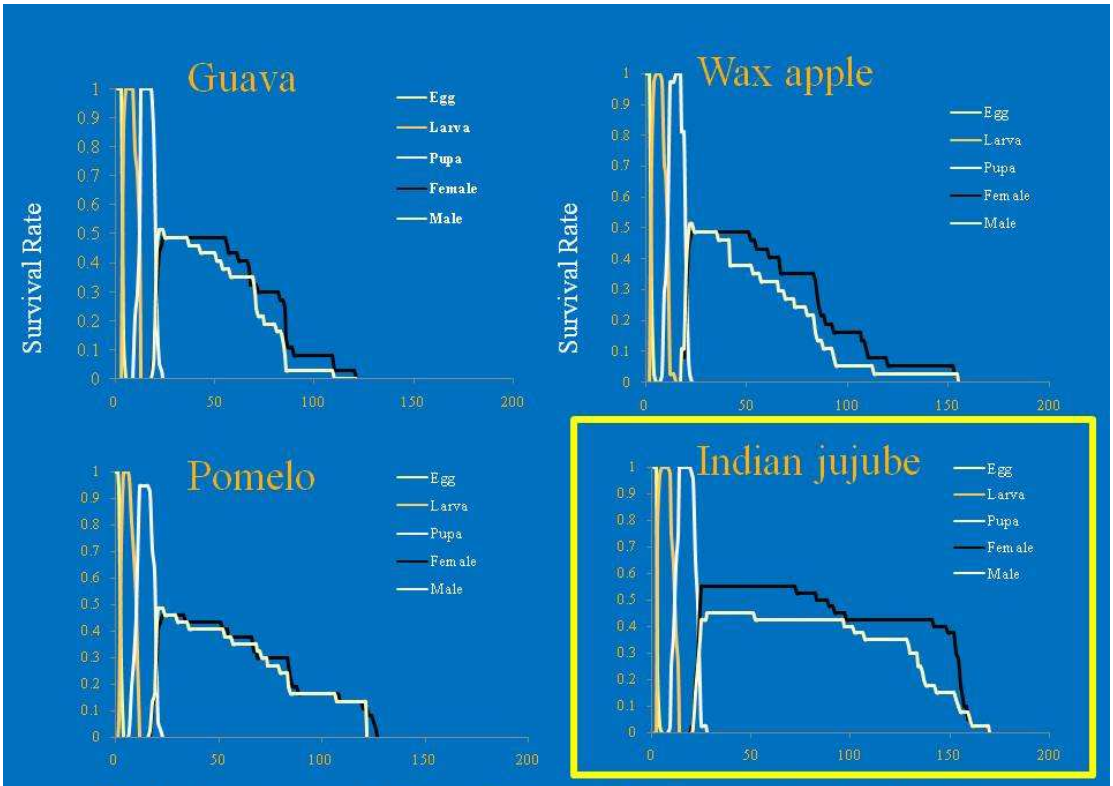


Fig. 3. Age-stage survival rate of oriental fruit fly reared on four host plants.

Table1. Means, standard errors, and sample sizes (in parentheses) of adult preoviposition period (APOP), total preoviposition period (TPOP), adult longevity, and fecundity of oriental fruit fly reared on four host plants

Host Plant	APOP	TPOP	Fecundity (eggs/female)	Adult longevity (d) Female	Male
Indian jujube	11.8±0.59a* (22)	34.1±0.60a (22)	1132.9±139.55a (22)	138.9±6.41a (22)	131.9±6.73a (18)
Wax Apple	12.0±0.81a (18)	32.9±0.69b (18)	346.2±82.08b (18)	92.5±6.94b (18)	72.6±7.19b (19)
Guava	11.9±0.47a (18)	31.9±0.32b (18)	426.2±102.3ab (18)	81.2±4.3b (18)	68.2±4.68b (19)
Pomelo	12.3±0.61a (17)	32.3±0.47b (17)	610.6±165.56a (17)	88.4±7.07b (17)	81.3±7.81b (18)

APOP: Adult preoviposition period. TPOP: Total preoviposition period. *: Means followed by the same letter within each column are not significantly different ($P<0.05$, Fisher's protected LSD test.)

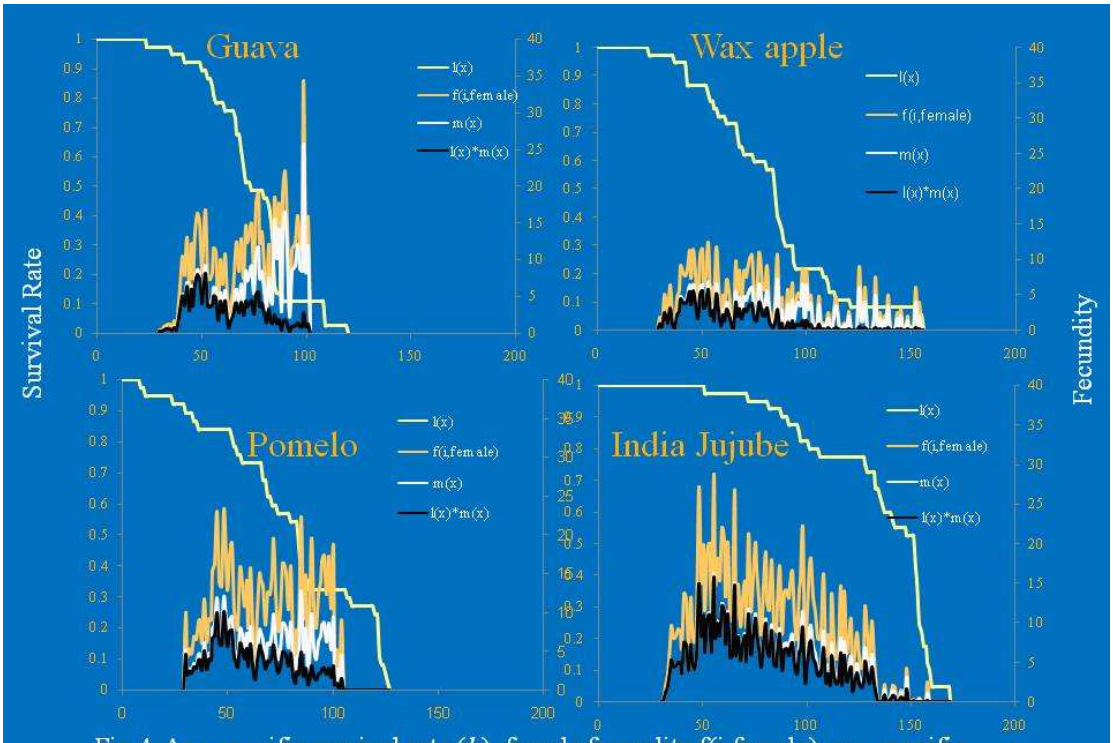


Fig.4. Age-specific survival rate (l_x), female fecundity f(i,female), age-specific fecundity (m_x), and age-specific maternity ($l_x m_x$) of oriental fruit fly reared on four host plants.

Table2. Population parameters (r; intrinsic rate of increase; λ, finite rate; R_0, net reproductive rate; T, mean generation time; and GRR, gross reproductive rate.

Host plant	N	*GRR*	R_0	T	*r*	λ
India Jujube	**40**	**689.9a* (127.9)[z]**	**622.8a (58.5)**	**55.2a (1.5)**	**0.1168a (0.0047)**	**1.1239a (0.0053)**
Wax Apple	**37**	**303.8a (88.2)**	**168.4b (60.6)**	**48.7a (1.1)**	**0.1058a (0.0087)**	**1.1115a (0.0097)**
Guava	**37**	**453.7a (168.5)**	**207.3b (60.6)**	**53.8a (1.1)**	**0.1000a (0.0055)**	**1.1052a (0.0061)**
Pomelo	**37**	**408.5a (138.5)**	**280.6b (90.4)**	**48.7a (1.1)**	**0.1168a (0.0091)**	**1.1239a (0.0102)**

*: Means followed by the same letter within each column are not significantly different ($P<0.05$, Fisher's protected LSD test.)
Z: Standard error is estimated by using Jackknife method.

$$R_0 = (N_f / N) * Fecundity$$

- *N: the total number of eggs used for the life table at the beginning. N_f: the number of female adults emergence.*

Host plant	*F* (Fecundity)	R_0 Net reproductive rate
Indian Jujube	**1132.9 (22/40)**	**622.8**
Wax Apple	**346.2 (18/37)**	**168.4**
Guava	**426.2 (18/37)**	**207.3**
Pomelo	**610.6 (17/37)**	**280.6**

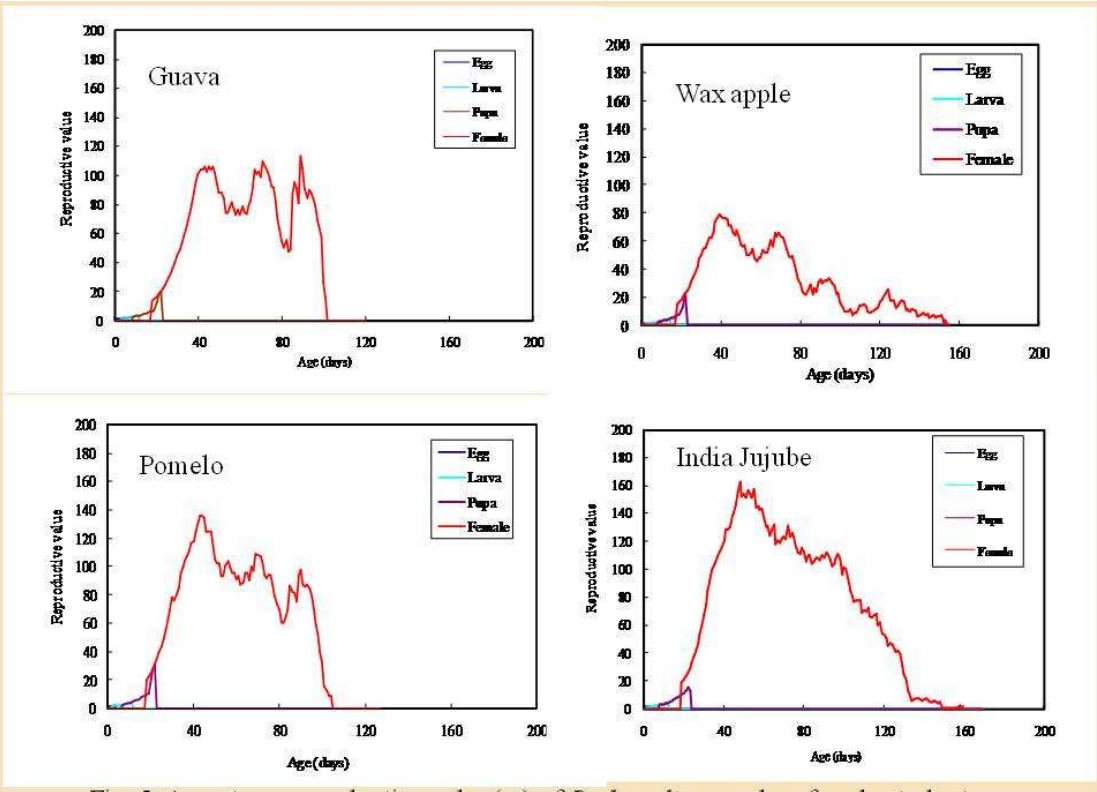


Fig. 5. Age-stage reproductive value(v_{ij}) of *B. dorsalis* reared on four host plants.

Conclusion

- Based on the age-stage, two sex life table, the oriental fruit flies reared on guava, wax apple, pomelo, and Indian jujube, have similar ecological potential increase rate.
- The age-stage, two-sex life table gives a correct and comprehensive description of the life history. The ecological database of life tables and others will be useful in the future for the population prediction and management of the fruit fly.

附件二：**海報摘要**：以生命表評估錨紋瓢蟲成蟲性比例與密度對其族群的影響（余志儒）

Using the Two-Sex Life Table for Assessing the Sex Ratio, Density and Discard Strategy in *Lemnia biplagiata* (Coleoptera: Coccinellidae) Adult Group Culture Program

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Lemnia biplagiata (Swartz) is one of the most common ladybeetle species in Taiwan. Because both larvae and adults can potentially utilize many species of aphids as prey, it has great potential as biological control agent. The effects of varying sex ratios and density on mass rearing of *L. biplagiata* on cotton aphids (*Aphis gossypii* Glover) as prey were studied using the age-stage, two-sex life table. The cohort life tables of five sex ratios (1:1, 2:1, 4:1, 6:1 and 8:1 [female: male]) were collected in the laboratory using 12 liter cages as rearing containers.. Our results showed that the net reproductive rate (R_0) was 390.5, 601.9, 727.1, 798.7 and 684.4, respectively, for the above sex ratios. The two treatments of 4 and 6 females paired with 1 male produced the highest R_0 values. The intrinsic rate of increase (r) of the "4:1" ratio, 0.2102, was higher than the 0.2006 value found in the "6:1" ratio. The apparent "optimal" sex ratio of 4:1 (female: male) was then used in the density study using a 12 liter cage. The net reproductive rate (R_0) was 727.1, 729.9, 723.7, 691.1, and 574.3 for densities of 4 × 1, 8 × 2, 16 × 4, 24 × 6 and 32 × 8 (females × males), respectively. The optimal density per cage was found to be 16 × 4 (females × males) in respect to space and labor. For determining the ideal discard age, the ratio of production rate/cost was used as the major criterion. A cumulative productive rate up to discard age 88 d was 635.5 for the density 16 × 4 (female × male). Our results demonstrated that life tables, sex ratios, and densities should be taken into consideration when initiating a cost-efficient mass-rearing program.

Key words: *Lemnia biplagiata*, two-sex life table, sex ratio, discard strategy, group culture

Chi, H. 2009. TWOSEX-MSChart: a computer program for the age-stage, two-sex life table analysis. http://140.120.197.173/Ecology/Download/Twosex-MSChart.zip.

Yu, J. Z., Chi, H. Chen, B.H., 2005. Life table and predation of *Lemnia biplagiata* (Coleoptera: Coccinellidae) fed on *Aphis gossypii* (Homoptera: Aphididae) with a proof on relationship among gross reproduction rate, net reproduction rate, and preadult survivorship. Ann. Entomol. Soc. Am., 96: 475-482.

附件三：台灣瓜實蠅區域防治現況

Recent Progress of Area-wide Melon Fly (*Bactrocera cucurbitae*) Control in Taiwan

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Melon fly, *Bactrocera cucurbitae*, is the most import Tephritid fruit fly on Cucurbitaceae in Taiwan. More than 40,000 ha economic crops including bitter gourd, loofah, cucumber, pumpkin, watermelon, cantaloupe and honeydew melon have been severely damaged for decades. Cover spray is the most convenient and common control practice for the farmers, but usually only with mediocre control effect.

The area-wide control concept has been introduced into Taiwan in 2000 for the oriental fruit fly control program, and was first tested on melon fly in bitter gourd during 2006. Field sanitation, male annihilation using cuelure and naled, and food baiting using GF-120 were the three control tactics used for testing. Primitive field trials in individual bitter gourd orchards of Pei-Tou Township in Chang-Hua County showed great reduction in melon fly density and damage rate, and had attracted the interest of growers from other townships in the demonstration sessions.

Upon the request of growers from Yu-Chih Township of Nan-Tou County, area-wide control program was initiated in the Tou-Ser basin covering acreage of 130 ha with 40 ha loofah orchards in 2008. In addition to field sanitation, male annihilation and food baiting, management of roosting plants and use of torula yeast are emphasized. Due to the impact of rainfall, food baiting using torula yeast pellets in the MacPhail trap is well accepted, which can attract both male and female flies for one month. A mandatory control program using the above control tactics has been organized by Yu-Chih Farmer Association in 2009. Intensive field tests and fine tune the application techniques of torula yeast are still ongoing.

Key words: area-wide control, *Bactrocera cucurbitae*

Recent Progress of Area-wide Melon Fly (*Bactrocera cucurbitae*) Control in Taiwan

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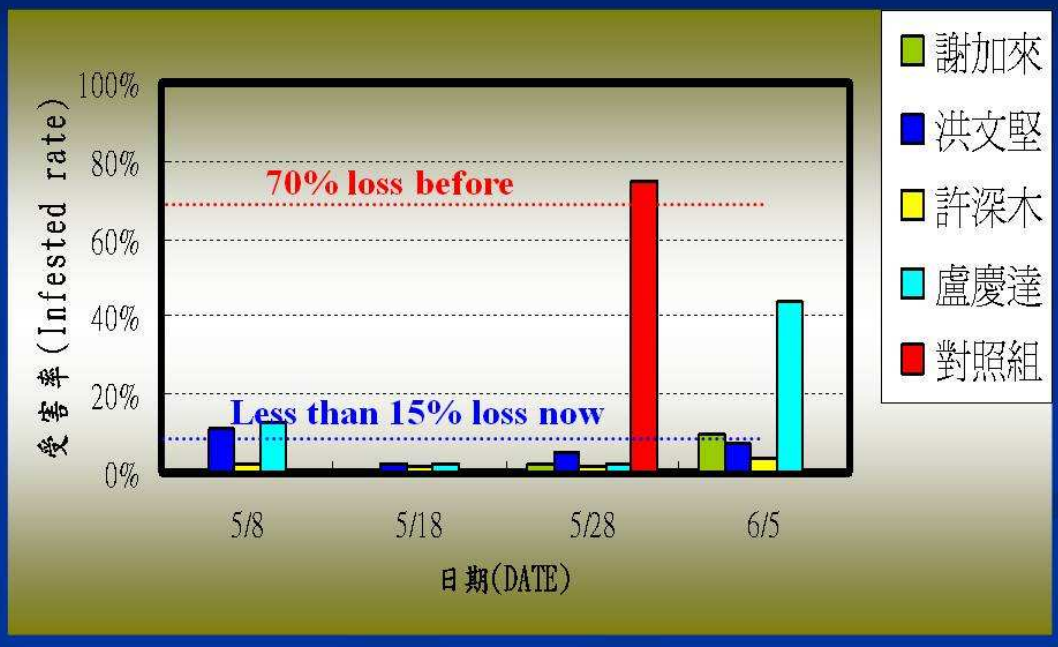
Taiwan Agricultural Research Institute, TAIWAN

Objectives of AW Melon Fly Control

- Melon fly, *Bactrocera cucurbitae* Coquillett, attacks more than 130 host crops belong to *Cucurbitaceae* and *Solanaceae*, which include watermelon, cantaloupe, pumpkin, cucumber, bitter gourd, luffa, tomato, eggplant, etc.
- To minimize crop losses, combination use of cultural practices and area-wide control tactics are tested.

Bitter gourd production in Pei-Tou, 2006

Bitter gourd yield increase greatly after adapting AW control practice in 2006



National Science Council Project, October 2007 ~ September 2008

Basic information of the townships participated in the AW MF control program

Township	Crop species	Testing periods	Total acreage, ha	Testing acreage, ha	AW control	Orchard control	Intensive testing	No. of Participant
Pei-Tou	Bitter gourd Pumpkin	Mar. – Oct.	10	2		✡	✡	7
Hsi-Lo	Bitter gourd	Mar. – Oct.	20	4		✡		11
Da-Chia	Bitter gourd	May – Sept.	20	10		✡		12
Yu-Chih	Luffa	Mar. – Oct.	130	30	✡		✡	60
Pu-Li	Luffa	Apr. – Sept.	160	40		✡		20
Tou-Nan	Luffa	Feb.-Jul.-Dec.	100	45		✡		40
Tai-Pao	Cantaloupe	Year round.	60 x 2	80		✡	✡	20
Yi-Chu	Cantaloupe	Sept.- Apr.	150 x 2	300	✡		✡	40
Er-Lung	Watermelon	Jan. - May	2000	800	✡			
	Cantaloupe	Jul. - Oct.	2000	800		✡		

Control Tactice for Melon Fly Control

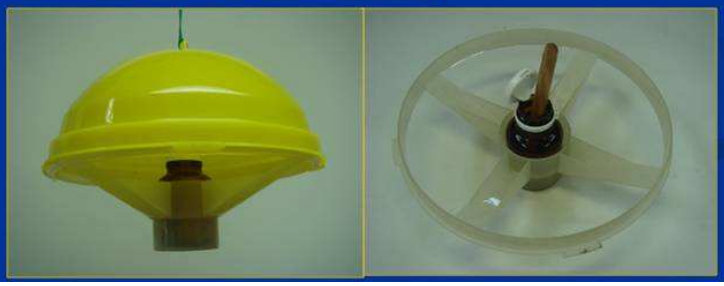
- Farmer education
- Constructing MF density monitoring system
- Enforcing field sanitation
- Testing AW control tactics
  - Male annihilation
  - Protein bait spray & trap crops


Farmer
education


瓜實蠅防治策略
清園
滅雄
滅雌
1
2
3
1、清園：已被產卵的被害果內幼蟲化蛹及羽化後會持續為害，應將廢棄果集中於收集桶或垃圾袋內，並定期銷毀 。
2、滅雌：為減少瓜實蠅雌成蟲在瓜果上產卵為害，自小果期開始，每7-10天於陷阱作物或田邊雜草噴灑含毒食餌加強誘殺。
3、滅雄：全期於瓜園內外通風處懸掛含克蠅、甲基丁香油及乃力松之誘殺板，誘殺田間雄蟲，減少其與雌蟲交尾機會。

Field sanitation - Da-Chia, 2007~

Male annihilation (Cuelure + ME + Naled)



Food baiting on trap plants

Cantaloupe production in Tai-Pao, 2007.10~

Testing area : 80 ha
Orchard acreage : 60 ha
Participated farmers : 20

Demonstration session for AW MF control

Application of Torula yeast (2008~)

- Female density monitoring inside the orchard
- Mass trapping?

Torula yeast pellets

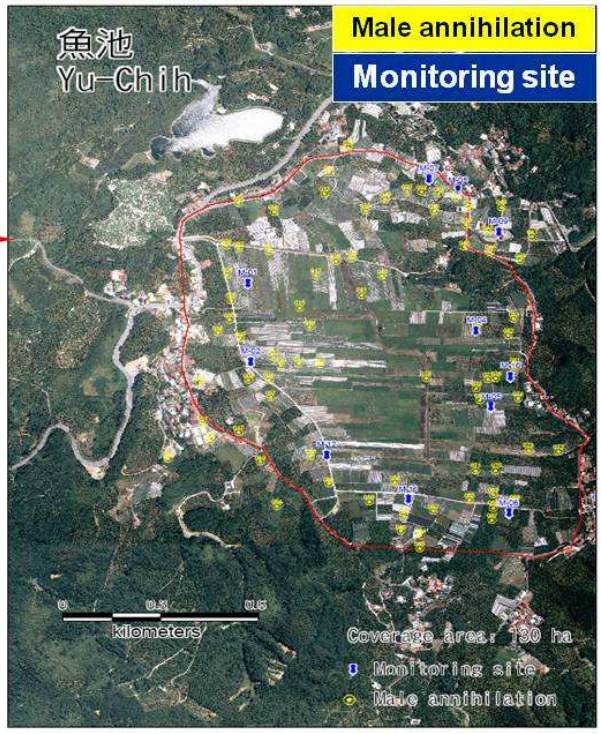
MF adults trapped by Torula yeast

Setting day \ Collection day	Site A (Pumpkin) Fly / trap / 5day		Site B (Bitter Gourd) Fly / trap / 5day		Site C (Bitter Gourd) Fly / trap / 5day	
	25th	30th	25th	30th	25th	30th
♂ catch						
0th	14.5 ± 14.8	13.5 ± 6.4	1.0 ± 1.4	0.0 ± 0.0	3.0 ± 0.0	8.5 ± 7.8
10th	22.5 ± 2.1	10.5 ± 2.1	7.0 ± 0.0	1.5 ± 0.7	2.0 ± 1.4	14.0 ± 2.8
20th	17.5 ± 14.8	14.0 ± 11.3	5.5 ± 0.7	0.0 ± 0.0	3.0 ± 0.0	5.0 ± 2.8
♀ catch						
0th	52.0 ± 39.6	61.5 ± 47.4	10.0 ± 1.4	1.5 ± 0.7	32.5 ± 3.5	45.0 ± 41.0
10th	67.5 ± 4.9	60.0 ± 22.6	38.0 ± 18.4	7.5 ± 2.1	21.0 ± 11.3	37.0 ± 5.7
20th	62.0 ± 29.7	34.5 ± 4.9	25.0 ± 8.5	4.5 ± 0.7	23.5 ± 9.2	35.0 ± 28.3
Total						
0th	66.5 ± 54.4	75.0 ± 20.5	11.0 ± 2.8	1.5 ± 0.7	35.5 ± 3.5	53.5 ± 48.8
10th	90.0 ± 7.1	70.5 ± 53.7	45.0 ± 18.4	9.0 ± 2.8	23.0 ± 12.7	51.0 ± 8.5
20th	79.5 ± 44.5	48.5 ± 16.3	30.0 ± 9.2	4.5 ± 0.7	26.5 ± 9.2	40.0 ± 25.5

AW MF Control in Yu-Chih Township (2008~)

Luffa orchards in Tou-Ser Basin

Male annihilation



Luffa culture practice in Yu-Chih

Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec

Transplant

Bloom

Harvest

Control Strategy

Field sanitation

Male annihilation

Food baiting

GF-120

Torula yeast

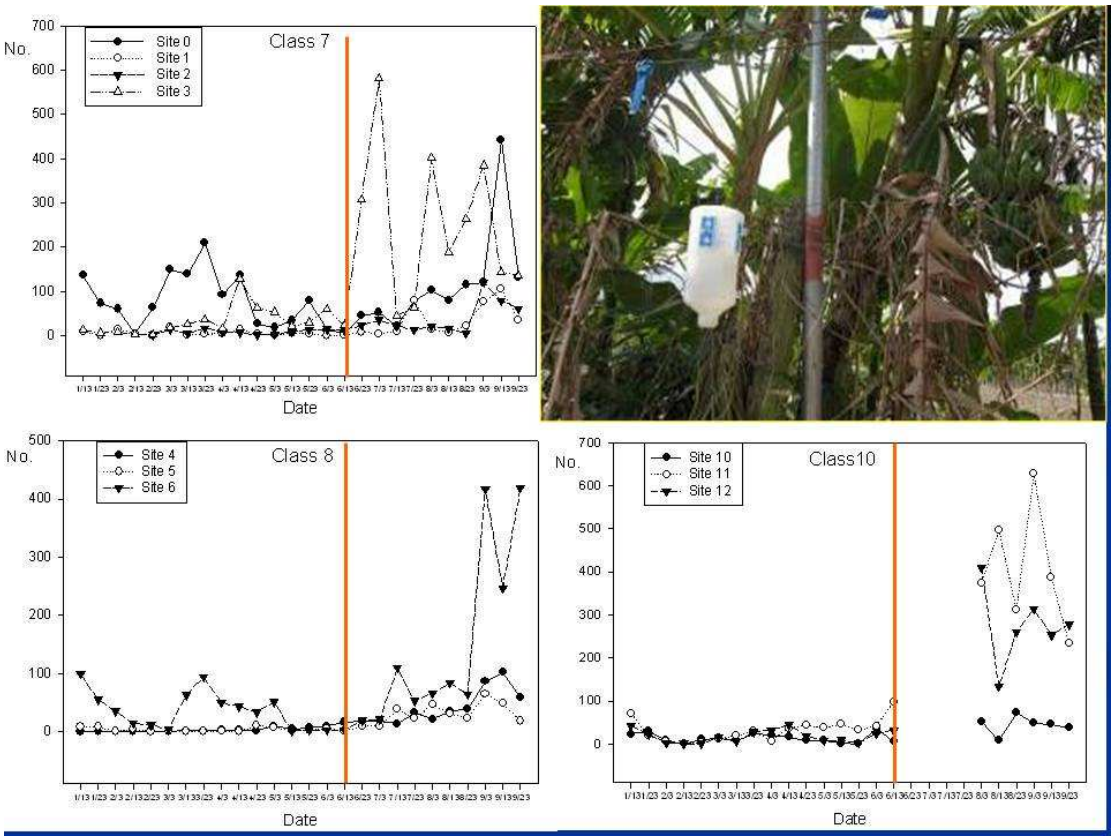
Luffa Production in Yu-Chih Township

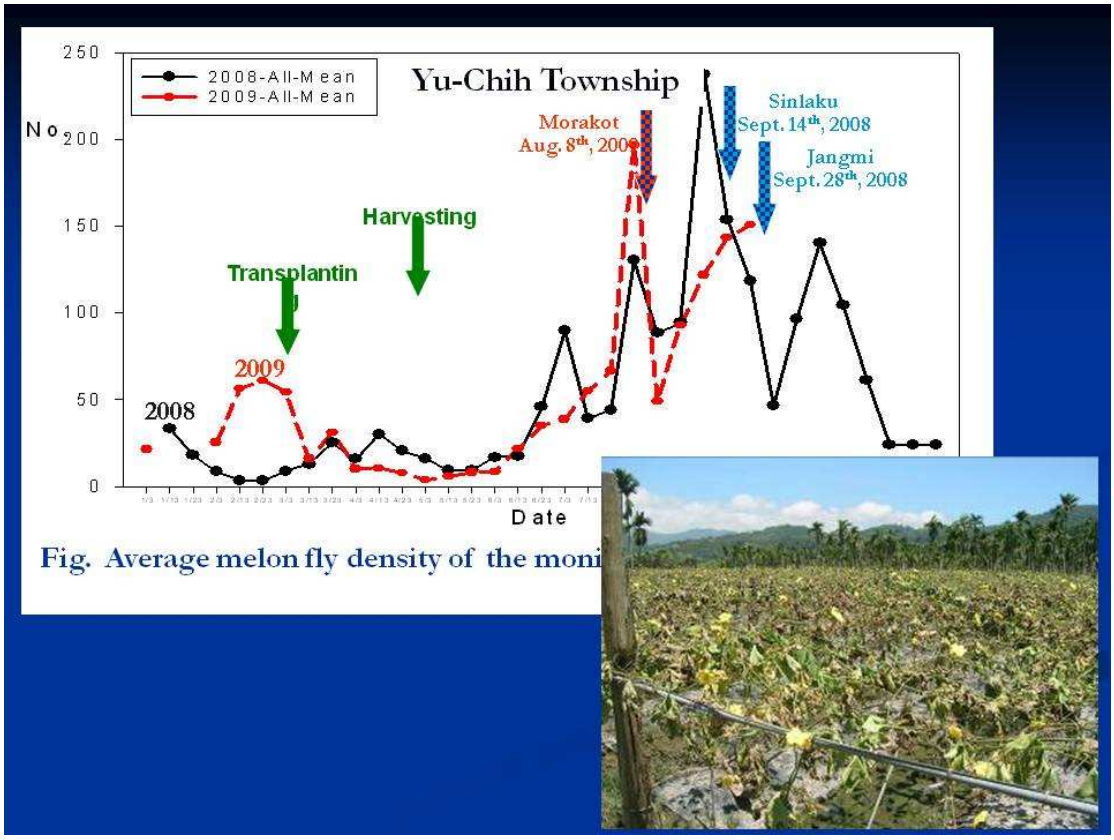
Total acreage: 130 ha

Luffa orchard: 43 ha

Participated farmers: 60

Mixture of *naled, methyl eugenol and cuelure* in fiber board


Class 7
Site 0
Site 1
Site 2
Site 3
No.
Date
Class 8
Site 4
Site 5
Site 6
Class10
Site 10
Site 11
Site 12


Yu-Chih Township
2008-All-Mean
2009-All-Mean
Morakot
Aug. 8th, 2009
Sinlaku
Sept. 14th, 2008
Jangmi
Sept. 28th, 2008
Harvesting
Transplantin
2009
2008
No
Date
Fig. Average melon fly density of the moni

Male annihilation

Mixture of *naled, methyl eugenol and cuelure* in brown bottle

Field sanitation - damage luffa in fertilizer bags

Field sanitation - damage luffa in plastic can

Food baiting using umbrella trap

with GF-120, 4-8 time dilution, weekly application

Food baiting using McPhail trap

2 torula yeast pellets per trap, change monthly

Weekly fly catch using torula yeast, 2008

Trial 7-3	July 23rd		Aug. 6th		Aug. 13th		Aug. /20th	
July 9th & Aug. 6th	♂	♀	♂	♀	♂	♀	♂	♀
1	144	282	117	206	86	211	196	413
2	109	153	172	323	78	128	102	203
3	106	159	116	233	80	137	77	122
4	182	184	125	189	66	156	66	101
5	93	192	193	418	53	90	98	128
6	163	198	74	184	84	173	57	109
7	166	253	165	217	90	178	99	142
8	141	134	135	297	51	117	63	160
9	138	172	119	316	141	238	109	210
10	147	198	55	101	46	76	29	70
Damage rate	23%		20%		15%		15%	
Ck field	50%		40%		38%		33%	

Table 1. Comparison of *B. cucurbitae* infestation rate of small (A) and large (B) luffa sampled from 12 orchards in Yu-Chih Township, 2009

Sampling date (No. of days after first treatment[Y])	Percentage infestation[Z] ± SEM			
	Torula yeast	GF-120	Torula yeast + GF-120	Control
A (<8cm)				
July 30 (0)	28.3 ± 3.6a[Y]	45.8 ± 2.9a	29.2 ± 7.1a	20.0 ± 5.4a
Aug. 6 (7)	22.5 ± 1.9c	30.8 ± 2.2b	29.2 ± 6.2bc	42.5 ± 3.6a
Aug. 27 (28)	18.3 ± 1.1b	32.5 ± 2.6a	21.3 ± 2.2ab	36.3 ± 7.5a
Sept. 3 (35)	30.4 ± 1.5b	45.8 ± 2.9a	20.0 ± 8.8b	49.6 ± 10.5a
B (>8cm)				
July 30 (0)	10.4 ± 3.3a	27.5 ± 10.4a	12.5 ± 1.9a	25.0 ± 9.5a
Aug. 6 (7)	13.8 ± 3.1a	18.3 ± 5.3a	14.6 ± 1.8a	23.8 ± 5.9a
Aug. 27 (28)	7.9 ± 2.5b	14.2 ± 2.2ab	14.3 ± 1.4ab	39.3 ± 14.4a
Sept. 3 (35)	20.4 ± 1.1a	39.3 ± 5.7a	22.9 ± 4.8a	46.3 ± 11.9a

[Z]: Averaged result of three orchards. 80 small and 80 large luffa were examined per orchard.
[Y]: Values within each treatment followed by the same letters are not significantly different according to Fisher protected LSD test at the 0.05 level.