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The effect of common insecticides on Liriomyza trifolii (Burgess) (Diptera: Agromyzidae)【Research report】

非洲菊園內常用藥劑對非洲菊斑潛蠅 (Liriomyza trifolii (Burgess)) (雙翅目：潛蠅科) 之藥效探討【研究報告】

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Abstract

Seedlings of field bean with or without Liriomyza trifolii (Burgess) were used to study the effects of six insecticides (cartap, thiocyclam, triazophos, pyrazophos, abamectin, and cyromazine) on different life stages of L. trifolii by dipping method. The results showed that all these insecticides have a significant lethal effect on L. trifolii and can be used to control the leaf miner. The highest lethal effect was recorded for the larval stage, with a survival rate of only 0-5.8%. The second most effective period was the adult stage. Cartap and thiocyclam were the most potent compounds, and resulted in almost 0% survival rate, oviposition and feeding. The remaining four insecticides could only decrease the adults' 24-hour survivability by 2.1-41.0%, reduce the oviposition by 54.1-96.6% and the numbers of feeding stipples by 42.7-97.0%. Partial side effects to female flies, such as decreased longevity, fecundity and feeding stipples of insecticide treated adults beyond 24 hours, also occurred. The stage least affected was the egg stage for all tested insecticides, with a survival rate between 83.5-98.4%.

摘要

以帶蟲或不帶蟲菜豆苗 (Phaseolus vulgaris var. communis Aeschers) 浸漬法 (dipping method) 測試培丹 (cartap)、硫賜安 (thiocyclam)、三落松 (triazophos)、白粉松 (pyrazophos)、阿巴汀 (abamectin) 及賽滅淨 (cyromazine) 等六種藥劑對非洲菊斑潛蠅 (Liriomyza trifolii (Burgess)) 未成熟期或成蟲期之影響。結果得知上述六種藥劑均對非洲菊斑潛蠅具顯著之致死效果，確可供該蠅防治用。各藥劑對非洲菊斑潛蠅各蟲期之防治效能，均以幼蟲期最高，幼蟲之存活率各為 0～5.8%；其次為成蟲期，除培丹與硫賜安仍對成蟲 24 小時內之存活率、產卵量及取食刻點數各顯著降低 98.7～100、100 及 99.9% 外，其餘四種藥劑在處理後 24 小時內僅降低雌蟲之存活率 2.1～41.0%、產卵量 54.1～96.6% 及取食刻點數 42.7～97.0%，但對雌蟲 24 小時後之壽命、生殖力及取食刻點數等具部分影響。受藥劑影響程度最低者為卵期，卵之存活率均為 83.5～98.4%。

Key words: Liriomyza trifolii, insecticide, stages, field bean

關鍵詞: 非洲菊斑潛蠅、藥劑、蟲期、菜豆。

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非洲菊園內常用藥劑對非洲菊斑潛蠅 (*Liriomyza trifolii* (Burgess)) (雙翅目：潛蠅科) 之藥效探討

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摘 要

以帶蟲或不帶蟲菜豆苗 (*Phaseolus vulgaris* var. *communis* Aeschers) 浸漬法 (dipping method) 測試培丹 (cartap)、硫賜安 (thiocyclam)、三落松 (triazophos)、白粉松 (pyrazophos)、阿巴汀 (abamectin) 及賽滅淨 (cyromazine) 等六種藥劑對非洲菊斑潛蠅 (*Liriomyza trifolii* (Burgess)) 未成熟期或成蟲期之影響。結果得知上述六種藥劑均對非洲菊斑潛蠅具顯著之致死效果，確可供該蠅防治用。各藥劑對非洲菊斑潛蠅各蟲期之防治效能，均以幼蟲期最高，幼蟲之存活率各爲 0～5.8%；其次爲成蟲期，除培丹與硫賜安仍對成蟲 24 小時內之存活率、產卵量及取食刻點數各顯著降低 98.7～100、100 及 99.9% 外，其餘四種藥劑在處理後 24 小時內僅降低雌蟲之存活率 2.1～41.0%、產卵量 54.1～96.6% 及取食刻點數 42.7～97.0%，但對雌蟲 24 小時後之壽命、生殖力及取食刻點數等具部分影響。受藥劑影響程度最低者爲卵期，卵之存活率均爲 83.5～98.4%。

關鍵詞：非洲菊斑潛蠅、藥劑、蟲期、菜豆。

前 言

非洲菊斑潛蠅 (*Liriomyza trifolii* (Burgess)) 爲世界性重要之觀賞園藝與蔬菜作物害蟲 (Lindquist, 1983; Minkenberg and van Lenteren, 1986)。由於斑潛蠅對化學藥劑容易產生抗藥性 (Parrella *et al.*, 1984; Hara, 1986; Broadbent and Pree, 1989)，且廣效性藥劑對其寄生蜂具毒害影響 (Spencer, 1973)，以及防治斑潛蠅藥劑之有效壽命 (effective life) 不及 2 年 (Leibee, 1981) 或僅 2 年 (Poe and Strandberg, 1979) 等因素，致使斑潛蠅防治不易。針對此點，多位學者建議以降低施藥頻率與劑量 (Mason *et al.*, 1989) 及採取藥劑輪用 (Trumble, 1985a; Ferguson, 2004) 等方法，可減緩斑潛蠅抗藥性之發展。在臺灣，非洲菊斑潛蠅自 1988 年 2 月於臺中大坑地區首次被發現後，雖一度帶給農作物極大之威脅 (Wang and Lin, 1988; Lin and Wang,

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1989)，但於 1988 與 1989 年，即分別於蔬菜與非洲菊上篩選出對非洲菊斑潛蠅具有效防治之七種藥劑，如達馬松 (methamidophos)、巴拉松 (parathion)、三落松 (triazophos)、陶斯松 (chlorpyrifos)、硫賜安 (thiocyclam)、培丹 (cartap) 及賽滅淨 (cyromazine) 等 (Cheng, 1989; Liu and Wang, 1992)。本研究以行政院農業委員會審定植物保護手冊中推薦防治非洲菊斑潛蠅之藥劑—培丹、硫賜安、三落松、阿巴汀 (abamectin) 及賽滅淨，與臺中大坑地區花農自行防治白粉病之藥劑—白粉松 (pyrazophos) 爲供試藥劑，於室內偵測此六種藥劑對非洲菊斑潛蠅各蟲期之藥效，期能將結果提供非洲菊園內病、蟲及蟎害綜合防治之參考。

材料與方法

一、寄主植物之栽培

每週定期浸泡菜豆 (*Phaseolus vulgaris* var. *communis* Aeschers) 種子 300 粒，在 25ºC 下經 7 小時種子吸水飽滿後，將其瀝淨，置於塑膠盤內進行催芽，期間並蓋上另一塑膠盤以保持濕度，待 14 小時種子發根後，即移種在溫室置有 3 號蛭石之穴盤 (長 36.5 cm，寬 28 cm，高 4.5 cm；30 穴) 內。每天澆水，經 10～13 天，菜豆苗發育至株高 15～20 cm，眞葉 (primary leaf) 葉寬達 7～9 cm 時，即可供室內非洲菊斑潛蠅產卵與藥劑試驗用。

二、斑潛蠅之採集

在臺中大坑非洲菊園內採集被非洲菊斑潛蠅幼蟲爲害之葉片，攜回室內並將被害葉放入塑膠盤內，待幼蟲化蛹，然後將蛹置入 22 × 20 cm 壓克力筒內，羽化成蟲後，供做飼育之蟲源。

三、斑潛蠅之繁殖

參照 Chien and Ku (1996) 飼育非洲菊斑潛蠅之方法，在室內 25°C 定溫下，以溫室內培養之菜豆苗 (株高 15～20 cm、眞葉寬 7～9 cm) 供非洲菊斑潛蠅產卵及幼蟲發育。

四、供試藥劑與豆苗浸藥之處理方法

供試藥劑　六種供試藥劑分別選自植物保護手冊內推薦防治非洲菊斑潛蠅之五種殺蟲劑—培丹、硫賜安、三落松、阿巴汀及賽滅淨 (Anonymous, 2004)，及加上花農慣行於非洲菊園內防治白粉病之一種殺菌劑—白粉松。藥劑種類、濃度、化學類別、使用形態及出品公司等詳見表一。

帶蟲或不帶蟲豆苗之預備　在 25°C 定溫下，將 80 隻非洲菊斑潛蠅雌蟲接入內置有 30 株 (株高 15～20 cm、眞葉寬 7～9 cm) 菜豆苗之繁殖網箱 (長 75 cm，寬 55 cm，高 50 cm)，經產卵 7 小時 (上午 9 點至下午 4 點) 後，將眞葉內帶有卵之菜豆苗移出，並放置於溫度 25°C、相對濕度 65～85% RH 及光周期 14:10 (L:D) (上午 5 點至下午 7 點間照光) 下之室內繼續飼養，以供後述藥效試驗，包括帶有卵 (產卵後第二日) 或帶有第三齡幼蟲 (產卵後第六日) 豆苗之試驗材料。另準備未經非洲菊斑潛蠅雌蟲產卵之相同大小豆苗，做爲不帶蟲豆苗之試驗材料。所有供試之帶蟲或不帶蟲豆苗均祇留有 2 片眞葉，若有複葉 (trifoliate leaf) 長出均摘除之。

帶蟲或不帶蟲豆苗浸漬藥劑之處理　在 25°C 下，各將眞葉內帶有 20～40 粒卵之單株菜豆苗、眞葉內帶有 30～40 隻第三齡幼蟲之單株菜豆苗、及不帶蟲之單株菜豆苗，齊根剪下分別倒插浸漬在盛有稀釋藥液之 2000 ml

表一　供試藥劑種類、濃度、化學類別、使用形態及出品公司
Table 1.　Chemicals and concentrations used in this study and their characters

Common names and formulation	Dilution factor	Chemical class	Use type	Manufacturer
Cartap 50% S.P.	1000	nereistoxin	insecticide	Harvest Chemical Co., Ltd.
Thiocyclam 50% W.P.	1000	nereistoxin	insecticide	Worldwide Agrochemical Co., Ltd.
Triazophos 40% E.C.	1000	organophosphate	insecticide, acaricide nematicide	Gharda Chemicals Ltd., India
Pyrazophos 30% E.C.	2000	organophosphate	insecticide, fungicide	BASF Taiwan Ltd.
Abamectin 2% E.C.	2000	avermectins	insecticide, acaricide nematicide	Syngenta Taiwan Ltd.
Cyromazine 75% W.P.	5000	triazine	insecticide (insect growth regulator), acaricide	Syngenta Taiwan Ltd.

塑膠杯內 1 分鐘，其後再將前述已浸藥後之豆苗分別插入試管架上已盛水之試管內 (1.5 × 7 cm)，待 30 分鐘豆葉表面之藥液自然風乾形成均勻藥膜後，再距豆苗剪口 5 cm 處以海綿片束紮，並直插入罐蓋上有圓孔（直徑 1.5 cm）之盛水塑膠罐（4 × 5 cm）底部，供各項試驗用。另設浸水處理之對照組，其方法與過程與浸藥處理相同，僅豆苗浸漬藥劑時，對照組係以水替代之。

五、卵期施藥對各未成熟期之影響

於 25°C 定溫下，在帶蟲 (卵) 豆苗浸藥處理後之第三天，記錄第一齡幼蟲數與未孵化卵數，以計算卵之存活率。第四天起，每日記錄各齡幼蟲數、蛹數、成蟲數及幼蟲之食痕數。食痕率之計算爲 ((食痕數 ÷ 第一齡幼蟲數) × 100)。第一齡與第二齡幼蟲之存活率，分別代表第一齡與第二齡幼蟲之完整食痕率。另設僅浸水處理之帶蟲 (卵) 豆苗爲對照組。每處理各做 10 重複。

六、第三齡幼蟲期施藥對未成熟期存活率與蟲體大小之影響

於 25°C 定溫下，在帶蟲（第三齡幼蟲）豆苗浸藥處理後之第二天，記錄蛹數、死亡幼蟲數及蛹體大小，以計算藥劑對第三齡幼蟲之存活率與蛹體大小之影響。第十天起，每日記錄羽化之成蟲數與成蟲大小，以計算藥劑對蛹之存活率與對成蟲大小之影響。另設僅浸水處理之帶蟲（第三齡幼蟲）豆苗爲對照組。每處理各做 10 重複。

七、藥劑對成蟲之影響

豆苗浸藥後接蟲 24 小時之處理　爲觀測成蟲與浸藥豆苗接觸 24 小時內之存活率、產子代數及取食刻點數，乃在 25°C 定溫下，早上 9 點將 1 日齡已交尾成蟲 20 對 (羽化後第二日) 置入 20 × 25 cm 之壓克力筒內，除供應 2 株已浸藥處理後之不帶蟲豆苗供其產卵與取食外，另以細毛筆將純蜂蜜塗於壓克力筒內壁供應成蟲食用。24 小時後，僅將成蟲移出，記錄雌、雄蟲之存活數；豆苗仍留在原壓克力筒內，依 Chien and Ku (1996) 之方法，距雌蟲與藥劑接觸後之次日、第四日及第四～六日分別記錄原浸藥豆葉上雌蟲之取食刻點數、子代卵數 (未孵化卵數 +

表二　非洲菊斑潛蠅卵經不同藥劑處理後各未成熟期之存活率與幼蟲食痕率[1)]

Table 2. Survival rate of immature stages and mining rate of *Liriomyza trifolii* after its eggs were treated with various insecticides[1)]

Insecticides	Percent survival							Percent mining
	Egg	Larva				Pupa	Egg-pupa	
		1st	2nd	3rd	total			
Cartap	95.6 ± 1.4b[2)]	0c	-	-	0b	-	0b	2.3 ± 1.0b
Thiocyclam	97.0 ± 1.3ab	0c	-	-	0b	-	0b	1.8 ± 0.9b
Triazophos	83.5 ± 2.2c	0c	-	-	0b	-	0b	0b
Pyrazophos	98.4 ± 0.7ab	0c	-	-	0b	-	0b	7.3 ± 1.9b
Abamectin	96.4 ± 1.3b	0c	-	-	0b	-	0b	1.3 ± 0.7b
Cyromazine	97.3 ± 1.0ab	40.2 ± 3.0b	6.6 ± 2.5b	0b	0b	-	0b	100a
CK	99.0 ± 1.0a	97.8 ± 1.5a	100a	100a	97.8 ± 1.5a	84.5 ± 4.7	81.6 ± 4.5a	100a

[1)] Seedlings of field bean infested by 20-40 *L. trifolii* eggs were dipped in insecticide solution for 1 min. Untreated controls were dipped in distilled water instead. Each treatment had 10 replications, which contained one seedling in an individual acrylic cylinder (20 × 25 cm) and they were placed under 25°C, 14L:10D, and 65-85% R.H. 30 min after treatment.

[2)] Means ($\bar{x}$ ± SEM) within each column followed by the same letter are not significantly different ($p < 0.05$, LSD and *t*-test). Data were transformed to arcsin$\sqrt{x}$ prior to ANOVA.

第一齡幼蟲數）及子代第一齡至第三齡幼蟲數。另設僅浸水處理之不帶蟲豆苗爲對照組。每處理各做 3～5 重複。

接蟲 24 小時後存活個體之後續觀察　爲觀測成蟲經藥劑處理 24 小時後對其壽命、生殖力及取食刻點數之影響，乃在上述成蟲經接觸 24 小時豆苗藥膜處理後，自活存者中隨機選取 1 對成蟲，置入另一 20 × 25 cm 壓克力筒內，每日供應純蜂蜜與未經浸藥處理之單株不帶蟲豆苗，直至雌蟲死亡爲止。然後依 Chien and Ku (1996) 之方法，計數該蠅之壽命、生殖力及取食刻點數。對照組之雌蟲則是選自藥劑試驗中對照組之活存成蟲。每處理各做 4～19 重複。

八、統計分析

各項試驗資料利用 SPSS (Statistical Products and Services Solutions) 軟體先進行變方分析，再以最小顯著差 (LSD) 法或 *t* 值測試法檢測，並採 $p < 0.05$ 之顯著水準比較處理間之差異性。若遇百分率時，資料先進行角度轉換 (arcsine transformation)，再進行分析。

結　果

一、卵期施藥對各未成熟期之影響

非洲菊斑潛蠅卵經六種不同藥劑處理後，各藥劑對卵孵化之藥效均不佳，硫賜安、白粉松及賽滅淨等對斑潛蠅無殺卵效果，各處理組之孵化率 (97.0～98.4%) 與對照組之孵化率 (99.0%) 無顯著差異，三落松、培丹及阿巴汀等處理組卵之孵化率雖與對照組呈顯著差異，但仍各高達 83.5、95.6 及 96.4% (表二)。但若持續觀察孵化幼蟲在原浸藥處理豆葉上之發育，則發現在培丹、硫賜安、三落松、白粉松及阿巴汀等藥劑處理組中，卵孵化即死亡，致使各處理組第一齡幼蟲之食痕率不但僅

表三　非洲菊斑潛蠅第三齡幼蟲經不同藥劑處理後未成熟期之存活率與蟲體大小[1)]

Table 3. Survival rate of immature stages and body size of *Liriomyza trifolii* after its third instars were treated with various insecticides[1)]

Insecticides	Percent survival			Pupa size (mm)	Adult size (mm)	
	Larva	Pupa	Larva-pupa	Length	Length	Width
Cartap	0.6 ± 0.4b[2)]	0b	0b	-	-	-
Thiocyclam	3.2 ± 1.2b	20.0 ± 20.0b	0.7 ± 0.7b	1.16 ± 0.02b	0.87 ± 0.04b	0.30 ± 0.00b
Triazophos	5.8 ± 1.2b	12.5 ± 12.5b	0.4 ± 0.4b	1.12 ± 0.02b	0.87 ± 0.03b	0.30 ± 0.00b
Pyrazophos	1.5 ± 0.8b	0b	0b	-	-	-
Abamectin	0b	-	0b	-	-	-
Cyromazine	0b	-	0b	-	-	-
CK	97.5 ± 1.1a	83.2 ± 1.0a	81.1 ± 1.2a	1.86 ± 0.02a	1.89 ± 0.01a	0.57 ± 0.03a

[1)] Seedlings of field bean infested by 30-40 *L. trifolii* larvae were dipped in insecticide solution for 1 min. Untreated controls were dipped in distilled water instead. Each treatment had 10 replications, which contained one seedling in an individual acrylic cylinder (20 × 25 cm) and they were placed under 25°C, 14L:10D, and 65-85% R.H. 30 min after treatment.

[2)] Means ($\bar{x}$ ± SEM) within each column followed by the same letter are not significantly different ($p < 0.05$, LSD). Percentage of survival data were transformed to arcsin$\sqrt{x}$ prior to ANOVA.

爲 0～7.3%，且均屬第一齡幼蟲之不完整食痕。另在賽滅淨處理組中，該蠅幼蟲之食痕率雖高達 97.3%，但因第一齡、第二齡及第三齡幼蟲之存活率各爲 40.2、6.6 及 0%，因而第一齡與第二齡幼蟲所造成之完整食痕率，各占 40.2 與 6.6%，其餘 50.5% 之食痕率則屬第一齡幼蟲所造成之不完整食痕率（表二）。

二、第三齡幼蟲期施藥對未成熟期存活率與蟲體大小之影響

供試之六種藥劑不但對非洲菊斑潛蠅第三齡幼蟲之化蛹有顯著之藥效，同時亦顯著影響其後該蠅之羽化，使得各處理組第三齡幼蟲與第三齡幼蟲至蛹期之存活率各銳減爲 0～5.8 與 0～0.7%。另硫賜安與三落松兩處理組之蛹體長度（1.16 與 1.12 mm）亦顯著較對照組蛹體長度（1.86 mm）各縮短 37.6 與 39.8%；成蟲大小方面，硫賜安與三落松兩處理組之體長（0.87 mm）與體寬（0.30 mm）亦顯著較對照組之體長（1.89 mm）與體寬（0.57 mm）各縮短 54 與 47.4%（表三）。

三、藥劑對成蟲之影響

豆苗浸藥後接蟲 24 小時之處理　非洲菊斑潛蠅成蟲經六種供試藥劑處理後，24 小時內各處理組中雌、雄蟲間之存活率雖無顯著差異，但就各藥劑對雌蟲之致死程度，培丹與硫賜安最高、白粉松次之、三落松與阿巴汀再次，賽滅淨則無；各藥劑對雄蟲之致死程度，亦以培丹與硫賜安最高、白粉松次之、三落松與阿巴汀及賽滅淨則無（表四）。子代數方面，各處理組雌蟲之產卵量（0～134 粒卵）顯著較對照組之產卵量（292 粒卵）減少 54.1～100%，其中以培丹、硫賜安及阿巴汀之藥效最強、三落松與白粉松次之、賽滅淨最小；同時藥劑亦影響卵之發育，如經三落松、白粉松、賽滅淨及阿巴汀處理之成蟲，卵之孵化率雖各高達 82.8、88.9、94.7 及 100%，但幼蟲之存活率卻均爲 0%（表四）。取食方面，各處理組雌蟲之取食刻點數（2～1690 個）顯著較對

表四　非洲菊斑潛蠅成蟲經不同藥劑處理 24 小時內之存活率、子代數及取食刻點數[1)]

Table 4. Survival rate, progeny and feeding stipples of *Liriomyza trifolii* adults treated with various insecticides within 24 hours[1)]

Insecticides	*n*	Percent survival of adult		No. progeny/20 females				Percent survival of egg	No. feeding stipples/ 20 females
		Female	Male	Egg	Larva				
					1st	2nd	3rd		
Cartap	4	1.3 ± 1.3Ad[2)]	0Ac	0d	0d	0c	0b	-	2 ± 1d
Thiocyclam	5	0Ad	0Ac	0d	0d	0c	0b	-	3 ± 3d
Triazophos	4	85.0 ± 7.4Ab	92.5 ± 4.8Aa	70 ± 7c	58 ± 4c	0c	0b	82.8 ± 2.3d	279 ± 50cd
Pyrazophos	3	58.3 ± 6.0Ac	53.3 ± 4.4Ab	67 ± 2c	59 ± 3c	0c	0b	88.9 ± 1.8c	450 ± 83c
Abamectin	4	90.0 ± 3.5Ab	87.5 ± 4.8Aa	10 ± 2d	10 ± 2d	0c	0b	100a	88 ± 6cd
Cyromazin	3	96.7 ± 1.7Aab	95.0 ± 2.9Aa	1134 ± 9b	127 ± 7b	51 ± 3b	0b	94.7 ± 1.2b	1690 ± 101b
CK	4	98.8 ± 1.3Aa	93.5 ± 3.1Aa	292 ± 24a	292 ± 24a	292 ± 24a	289 ± 24a	100a	2949 ± 303a

[1)] Seedlings of field bean were dipped in insecticide for 1 min. Untreated controls were dipped in distilled water instead. Each treatment had 3-5 replicates, which contained two seedlings in individual acrylic cylinder (20 × 25 cm). Thirty minutes after treatment, 20 pairs of 1-day old *L. trifolii* adults were released into the cylinder and placed under 25°C, 14L:10D, and 65-85% R.H.

[2)] Means ($\bar{x}$ ± SEM) of longevity followed by the same uppercase letter denote that there are no significant differences between sexes ($p < 0.05$, *t*-test). Means ($\bar{x}$ ± SEM) within each column followed by the same lowercase letter are not significantly different ($p < 0.05$, LSD). The percentage of survival data was transformed to arcsin$\sqrt{x}$ prior to ANOVA.

照組之取食刻點數（2949 個）減少 42.7～99.9%，其中以培丹、硫賜安、三落松及阿巴汀之藥效最強，白粉松次之，賽滅淨最小（表四）。

接蟲 24 小時後存活個體之後續觀察　成蟲經四種藥劑處理 24 小時後，移至未處理藥劑之豆苗上，記錄雌蟲壽命，結果顯示白粉松與阿巴汀兩處理組雌蟲壽命與對照組雌蟲壽命間無顯著差異，但三落松與賽滅淨兩處理組雌蟲壽命（13.1～13.6 日）卻顯著較對照組雌蟲壽命（21.6 日）減少 37.0～39.4%；雄蟲壽命方面，各處理組與對照組間均無顯著差異(表五)。生殖力方面，除阿巴汀外，其餘三種處理組之子代第三齡幼蟲數（196～282 隻)、蛹數（195～278 個）及成蟲數（169～233 隻）雖均顯著較對照組各減少 31.2～52.2、31.7～52.1 及 28.7～48.3%，但四種藥劑處理間卻無顯著差異（表五)。子代雌性比方面，四種藥劑間僅阿巴汀處理組之雌性比(0.48）顯著較對照組之雌性比（0.53）減少 9.4%，其餘各處理組之雌性比與對照組之雌性比間無顯著差異（表五)。取食刻點數方面，則僅白粉松處理組之取食刻點數（1121 點）顯著較對照組之取食刻點數（2309 點）減少 51.5%，其餘各處理組之取食刻點數與對照組之取食刻點數間無顯著差異（表五)。

討論與結論

一、藥劑類型對非洲菊斑潛蠅防治之影響

藥劑防治害蟲時，因藥劑化學類型(chemical class) 與其作用機制之不同，對害蟲防治效果亦不同。本試驗供試之六種藥劑各屬於不同之化學類型（表一)，如培丹與硫賜安爲海生類毒素殺蟲劑（nereistoxins)，三落松爲有機磷類（organophosphates）之殺蟲劑、

表五　非洲菊斑潛蠅成蟲經藥劑處理 24 小時後移至未施藥豆苗上之壽命、生殖力及取食刻點數[1)]

Table 5. The longevity, fecundity and feeding stipples of insecticide treated *Liriomyza trifolii* adults on untreated field bean seedling[1)]

Insecticides	*n*	Longevity (d)		Fecundity/female			Female proportion	No. feeding stipples/femae
		Female	Male	No. 3rd instars	No. pupae	No. adults		
Triazophos	10	13.1 ± 0.7Ab[2)]	9.8 ± 0.2Ba	282 ± 19b	278 ± 19b	233 ± 18b	0.52 ± 0.02ab	1909 ± 225ab
Pyrazophos	4	17.8 ± 2.0Aab	10.5 ± 2.9Aa	196 ± 37b	195 ± 36b	169 ± 34b	0.52 ± 0.04ab	1121 ± 230b
Abamectin	8	22.4 ± 2.0Aa	12.9 ± 2.8Ba	328 ± 34ab	327 ± 34ab	285 ± 30ab	0.48 ± 0.01b	2348 ± 247a
Cyromazine	5	13.6 ± 1.5Ab	8.0 ± 1.6Ba	261 ± 25b	251 ± 27b	205 ± 25b	0.52 ± 0.02ab	1876 ± 233ab
CK	19	21.6 ± 1.5Aa	13.2 ± 1.5Ba	410 ± 35a	407 ± 35a	327 ± 29a	0.53 ± 0.01a	2309 ± 161a

[1)] For every replicate, one pair of 2-day old *L. trifolii* adults that had survived after 24 h insecticide treatment were placed in the acrylic cylinder (20 × 25 cm) under 25°C, 14L:10D, and 65-85% R.H. Untreated field bean seedlings were provided every day.

[2)] Means ($\bar{x}$ ± SEM) of longevity followed by the same uppercase letter denote that there are no significant differences between sexes ($p < 0.05$, *t*-test). Means ($\bar{x}$ ± SEM) within each row followed by the same lowercase letter are not significantly different ($p < 0.05$, LSD). The percentage of survival data was transformed to $\arcsin\sqrt{x}$ prior to ANOVA.

殺蟎劑及殺線蟲劑，白粉松爲有機磷劑類之殺蟲劑 (Broadbent and Pree, 1989; Olszak, 1999; Youn *et al*., 2003) 與殺菌劑，阿巴汀爲土壤微生物製劑 (avermectins) 之殺蟲劑、殺蟎劑及殺線蟲劑，賽滅淨爲昆蟲生長調節劑 (insect growth regulator) 之殺蟲劑與殺蟎劑。前五種藥劑對昆蟲之作用機制爲胃毒或神經毒或接觸毒，因此不論對非洲菊斑潛蠅初孵化幼蟲或第三齡幼蟲之致死率均各達 100 與 94.2～100%；而賽滅淨對昆蟲與蟎之作用機制分別爲抑制昆蟲幾丁質之合成與蟎之生長調節，因而在該蠅卵期施藥後，卵之孵化率不但高達 97.3%，且幼蟲之死亡是隨發育而陸續發生，其第一齡、第二齡及第三齡幼蟲能完成發育者各占 40.2、6.6 及 0%；但若在第三齡幼蟲期施藥後，幼蟲之死亡率即高達 100%。

二、藥劑對非洲菊斑潛蠅蟲期之藥效

本試驗結果得知六種供試藥劑（培丹、硫賜安、三落松、白粉松、阿巴汀及賽滅淨）對非洲菊斑潛蠅各蟲期之防治程度，均以幼蟲期最高，幼蟲之存活率僅達 0～5.8%。受藥劑防治程度其次者爲成蟲期，除培丹與硫賜安仍對成蟲 24 小時內之存活率、產卵量及取食刻點數達 98.7～100% 之抑制外，其餘四種藥劑在 24 小時內僅降低雌蟲 2.1～41.0% 之存活率、54.1～96.6% 產卵量及 42.7～97.0% 取食刻點數，但對雌蟲 24 小時後之壽命、生殖力及取食刻點數等仍具部分影響。受藥劑防治程度最低者爲卵期，卵之存活率均各高達 83.5～98.4%。

三、藥劑對非洲菊斑潛蠅之防治效力

供試之六種藥劑因對非洲菊斑潛蠅幼蟲具高達 99.3～100% 之致死率，且各處理間無顯著差異，因而此六種藥劑均可推薦該蠅防治用。其中之白粉松因兼具殺非洲菊斑潛蠅 (Broadbent and Pree, 1989) 與殺菌之藥效，尚可供非洲菊白粉病之防治，而阿巴汀因兼具殺蟲與殺蟎之藥效，亦可供非洲菊上蟎類之防治。但若考慮成蟲之取食刻點與幼蟲食痕對觀賞植物之影響，對非洲菊斑潛蠅防治最佳之藥劑爲培丹、硫賜安及阿巴汀，其次者爲三

落松與白粉松，再次者爲賽滅淨。Poe *et al.* (1978)、Waddill (1978)、Trumble and Toscano (1983) 及 Trumble (1985b) 等曾建議當使用一種藥劑防治斑潛蠅前，應先測試該藥劑對其寄生蜂種類之影響，並據此作爲使用該藥劑之參考。異角釉小蜂 (*Hemiptarsenus varicornis* (Girault)) 與華釉小蜂 (*Neochrysocharis formosa* (Westwood)) 爲非洲菊斑潛蠅本地種之有效寄生蜂 (Chien and Ku, 1998, 2001a, b; Chien *et al.* 2004; Chien *et al.*, 2005a, b, c)。所以若考慮上述藥劑對本地寄生蜂之影響，仍需進一步試驗，Chien *et al.* (未發表資料) 認爲賽滅淨與兩種寄生蜂間之相容性較其他五種藥劑爲大，非洲菊斑潛蠅防治時若愼選賽滅淨，異角釉小蜂與華釉小蜂可獲得較佳的保育。

四、藥劑對非洲菊斑潛蠅致死能力外之影響

Robb 與 Parrella (1984) 曾測試兩種昆蟲生長調節劑施用在非洲菊斑潛蠅幼蟲後，確對其成蟲之生殖力具亞致死之影響 (sublethal effect)。本試驗證實六種藥劑不論施用於非洲菊斑潛蠅卵或第三齡幼蟲後，幼蟲之死亡率除高達 94.2～100% 外，硫賜安與三落松尙顯著降低其後 76～85% 蛹存活率及縮短 37.6～39.8% 蛹與 54% 成蟲之體長。至於成蟲方面，則發現三落松、賽滅淨、白粉松及阿巴汀四種藥劑除影響成蟲 24 小時內之存活率、子代數及取食刻點數外，尙影響成蟲 24 小時後之壽命、生殖力及取食刻點數。如三落松與賽滅淨可減少 37.0～39.4% 雌蟲壽命與 28.7～37.3% 子代成蟲數；白粉松則減少 51.5% 雌蟲取食刻點數與 48.3% 子代成蟲數；而阿巴汀對成蟲之影響最少，僅降低 9.4% 子代雌性比。

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The effect of common insecticides on *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae)

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ABSTRACT

Seedlings of field bean with or without *Liriomyza trifolii* (Burgess) were used to study the effects of six insecticides (cartap, thiocyclam, triazophos, pyrazophos, abamectin, and cyromazine) on different life stages of *L. trifolii* by dipping method. The results showed that all these insecticides have a significant lethal effect on *L. trifolii* and can be used to control the leaf miner. The highest lethal effect was recorded for the larval stage, with a survival rate of only 0-5.8%. The second most effective period was the adult stage. Cartap and thiocyclam were the most potent compounds, and resulted in almost 0% survival rate, oviposition and feeding. The remaining four insecticides could only decrease the adults' 24-hour survivability by 2.1-41.0%, reduce the oviposition by 54.1-96.6% and the numbers of feeding stipples by 42.7-97.0%. Partial side effects to female flies, such as decreased longevity, fecundity and feeding stipples of insecticide treated adults beyond 24 hours, also occurred. The stage least affected was the egg stage for all tested insecticides, with a survival rate between 83.5-98.4%.

Key words: *Liriomyza trifolii*, insecticide, stages, field bean

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